SOCIO-ECONOMIC IMPACT ANALYSIS
OF
DRAFT GUIDELINES
FOR THE
YUKON PLACER MINING INDUSTRY

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March 1983

FOREWARD

This socio-economic impact analysis for the Yukon Placer Mining Guidelines is one of several documents to be presented for public review. The purpose of this document is to present facts and information about both the placer mining and fishing industries in Yukon and to describe the potential impacts of the proposed guidelines. Such information is intended to provide assistance to the decision-makers rather than to make conclusions or recommendations about the desirability of implementing the proposed guidelines.

In this analysis, benefits and costs of the proposed guidelines have been assessed by comparing the negative impacts on the placer mining industry against the positive impacts for Yukon fisheries. Other types of benefits and costs would occur throughout the Yukon economy if the guidelines were implemented but for ease of analysis, only the sectors of the economy to be most affected have been examined here. In addition, the analysis sometimes relies on assumptions made necessary by the lack of detailed information about either industry. With these limitations in mind, any use of the information in this report should be done so with caution and with consideration of the context in which this material is presented.

This report has been prepared by the Environmental Protection Service, Environmental Strategies Directorate and Canadian Resourcecon Ltd. for the Department of Indian Affairs and Northern Development.

R E S U M E

Cette analyse de l'impact socio-économique concernant la ligne directrice proposée au sujet de l'exploitation des placers du Yukon a été executée par le Service de la Protection de l'Environnement,Direction des Stratégies Environnementales et Canadian Resourcecon Ltd. pour le Ministère des Affaires Indiennes et du Nord.

La mise en application de la ligne directrice proposée devrait engendrés et des coûts et des avantages supplémentaires.Afin d'évaluer ces coûts et avantages deux segments de l'économie du Yukon ont été etudiés,il s'agit de l'exploitation des placers et de l'activité de la pêche.

Le premier chapitre donne les renseignements généraux concernant cette ligne directrice proposée et en fait une brève description.

Dans le second chapitre,après une description du régime actuel,régissant l'utilisation de l'eau pour l'exploitation des placers,l'on retrouve une présentation de l'importance de cette activité pour l'économie du Yukon.Ensuite,une estimation quant au niveau de l'activité pour la période de 1983 à 1995,a été faite.Pour y parvenir il a été nécessaire de développer deux scénarios:le premier scénario (le pessimiste) considérait un prix moyen pour l'or,de $330 U.S. pour cette période tandis que le second (l'optimiste) considérait,lui un prix moyen de l'or de $700 U.S.

Le troisième chapitre consiste en une description des divers poissons (saumons et d'eaux douces) qui sont l'objet de pêche pour chacun des quatre types de pêcheries que l'on retrouve au Yukon soit: la pêche commerciale,domestique, Indienne et sportive.Leur localisation et leur ampleur sont ensuite presentées.

Ce chapitre se termine par une estimation du niveau de l'activité pour chacun de types de pêcheries et pour chacun des types de poissons, selon deux scénarios soit: une projection du Status Quo et une projection selon un taux de croissance optimiste pour chacune de pêcheries.

Le quatrième chapitre identifie et estime l'impact que devrait avoir l'application de la ligne directrice proposée sur l'activité de l'exploitation de placers selon les scénarios établis au chapitre 2. Il s'agit en fait de présenter les coûts qui devront être encourus par l'industrie et ils sont les suivants:

- diminution de la quantité d'or extraite des gisements
- coûts accrus pour:
  a) la construction de bassins de sédimentation permettant d'atteindre les normes prescrites pour les effluents liquides
  b) les frais de design par des ingenieurs professionnels pour les diversions de ruisseaux classifiés C
  c) la réhabilitation des sites par l'application d'une couche d'humus permettant la revégetation ainsi que le réaménagement des tas de débris stériles selon le profil des vallées.

Le cinquième chapitre identifie et estime l'impact que devrait avoir l'application de la ligne directrice proposée sur les pêcheries du Yukon selon les scénarios établis au chapitre 3. Il s'agit en fait de présenter les avantages pour les pêcheries qui découleront de l'accroissement du stock de poissons disponibles pour les pêcheries. Ces avantages découleront de deux impacts qu'aura la ligne directrice concernant la qualité

accrue des cours d'eau:
-réhabilitation des sites ayant déjà été exploités
-protection des sites ayant,du point de vue minier,un potentiel intéressant et qui pourront éventuellement faire l'objet d'exploitation dans un avenir prévisible,

Ces deux impacts permettront un accroissement de la population de poissons,en protégeant les sites de frai, en maintenant une quantité supérieure de nourriture et enfin en protégeant les poisoons de l'effet léthal engendré par la présence de solides en suspension dans l'eau,tels les silts et argiles.

Enfin le sixième chapitre est un résumé sommaire des <u>coûts et avantages supplémentaires</u> estimés aux chapitres 4 et 5.Ceux-ci sont de deux types soit:les effets d'allocation ou impacts directs sur les deux secteurs de l'économie qui ont été étudiés (l'exploitation des placers et les pêcheries) et enfin les effets autres que les effets d'allocation,tels les impacts secondaires et l'emploi.

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CHAPTER 1

BACKGROUND INFORMATION

1.1 Proposed Guidelines

The proposed Guidelines for the Yukon Placer Mining Industry represent a coordinated effort by the Department of Indian Affairs and Northern Development (DIAND), the Department of the Environment (DOE) and the Department of Fisheries and Oceans (DFO) to develop a new regulatory regime governing the use of water by the placer mining industry and to ensure the stability of the surrounding terrestrial area. The guidelines were developed and drafted by an interdepartmental working group comprised of officials from the three departments.

The guidelines as presented do not form a set of regulations to be established under a particular statute or number of statutes but rather they form a basis for consensus among the three federal departments whose mandates and responsibilities have the most significant impact on the placer mining industry. Once the guidelines have received public review and ministerial approval they may then be drafted into regulations under the appropriate existing federal statute or possibly under some new statute. It is expected that the guidelines will most likely be reflected in amendments to or additions to one or several of the following statutes: the Northern Inland Waters Act, the Yukon Placer Mining Act, the Fisheries Act, and the Territorial Lands Act.

The proposed guidelines will be applied to new and existing placer mining operations starting with the 1984 operating season.

There are two essential elements to the guidelines: the Development Plan and a Stream Classification System:

a) The development plan

All operators will be required to prepare a development plan. For existing operators, the plan will detail all the phases of their

planned workings beginning with the stage they are at when the guidelines are implemented. New operators will be required to submit a complete development plan and have approval prior to initiation of the project and issuance of water use licence or authorization.

The development plan will detail the property size and location, the basic geological features of the area, the exploration and assessment work that will be carried out on the property, the planned operations systems and the layout of the workings, the use and treatment of water, and the efforts that will be made to rehabilitate the area before it is abandoned.

The development plan also calls for the proponent to provide baseline environmental data on his location, but only if the proponent does not accept the classification (see the following section on stream classification) applied to his property or if he wishes to have his classification downgraded. Such information would cover water quality, the hydrological features of the area, and fish habitat.

b) Stream classification system

Under the classification system, streams or portions of streams (reaches) will be placed into one of five categories (A, B, C, D and an interim) category according to their biological importance and the past mining history. At this point in its development, the stream classification system uses the presence of fish and/or fish habitat as the primary measure of biological importance. In the future, however, it is expected that other resource values will be incorporated into the classification system.

An "A" category stream would have the highest biological importance rating, a "B" stream would have a high rating, a "C" would have a moderate rating, and a "D" stream would have the lowest biological importance rating. An interim "X" rating would be applied to those streams that have been severely degraded by past mining activity (presently called designated streams under the 1976

guidelines). This rating would be an interim rating since it is intended that these streams would eventually be upgraded to a category that would reflect their potential biological importance.

Two types of guidelines have been developed from the stream classification system: general guidelines and site specific guidelines.

c) General guidelines

The general guidelines establish a set of operating conditions to be applied to all areas regardless of their classification These conditions are general in nature and in effect they represent a set of "good housekeeping" practices. These include rehabilitation of the mined area, fuel storage and handling, domestic water use, garbage disposal, the disposal of solid waste material, measures to allow fish passage, and regular monitoring of effluent by the operator.

d) Site specific guidelines

The site specific guidelines are directly linked to the stream classification system and are outlined for each category of stream according to the environmental stress that each category of stream can endure. Thus, an "A" stream would have the most stringent conditions applied to it while a "D" or an "X" stream would have the least stringent conditions.

For "A" and "B" streams the site specific guidelines set varying standards for the rate and method of water acquisition, quality of wastewater discharge, leave strips, and the operation of equipment and machinery near the stream. No stream diversions will be permitted. The specific standards for "C" and "D" streams address rate and method of water acquisition, quality of wastewater discharge, and stream diversion. The standards for "X" streams are the same as those for "D" streams. (Appendix I).

It should be noted that some aspects of water use are not covered under these guidelines. Existing general requirements, including maintenance of works, spill reporting, sample collection, datas reporting, notice of cessation of operations, and liability are not discussed here but will continue to apply to future authorizations. In addition, site specific constraints will continue to determine water rights allocation and other measures particular to the site.

e) Compliance schedule

A very important aspect of the proposed guidelines is the compliance schedule. All conditions of the guidelines will become effective during the 1984 season. The development plan will be required for all existing operations and proponents of operations in new areas will be required to submit a development plan and have approval prior to initiation of the project.

The effluent standards will be phased in over five years for operations presently on "C", "D" and "X" streams. Operations on "A" streams will have one year to meet the ultimate effluent standard while those on "B" streams must meet the effluent standard in the first year that the guidelines become effective. (Appendix II). Operations starting work on creeks that have never been mined before will be required to meet the ultimate effluent standards for their stream classification in their first year of operation.

1.2 Purpose and Objectives

The proposed guidelines are intended to provide a resource management regime for the Yukon placer mining industry that will address the concerns and objectives of the three federal departments whose regulatory and surveillance activities include the placer mining industry -- DIAND, DOE and DFO. This management regime will establish a regulatory framework that will be administered through a "one window" approach with DIAND acting as the "one window". As such, DIAND will be

responsible for the coordination and implementation of the regulatory control and surveillance of the Yukon placer mining industry.

The objectives of these guidelines reflect the concerns of the three departments. They include the following:

1. The protection of fish and wildlife habitat, downstream water use and associated resources.
2. The mitigation of any environmental damage which may occur as a result of mining activities.
3. The rehabilitation of areas disturbed by mining activity.
4. The implementation of a management regime that is based on the principle of multiple resource management.
5. The adoption of a set of objective and clearly worded guidelines which can be translated into similarly clearly worded conditions on water use authorizations or licences.
6. The establishment of an objective and coordinated procedure for inspecting placer mining operations.

1.3 The Issue

Throughout much of its history, the Yukon placer mining industry has operated without much public concern for its effects on the environment. Consequently there were few controls placed on the industry. In more recent times, however, new impetus for further regulation of the industry has come from increased public concern over environmental protection and from the very rapid growth of the industry, particularly over the last five years.

At present the industry is regulated by guidelines which were established by the Yukon Territory Water Board in 1975. (Appendix III). These guidelines appear to be very general in nature and have been criticized by both Government and the industry. Government is concerned that the present guidelines do not adequately protect the environment and that the absence of clearly defined standards presents serious administrative problems in the areas of interpretation and enforcement.

Industry, through the Klondike Placer Miners Association (KPMA), has been very critical of the implicit discretionary authority given to the Controller of Water Rights to require that certain measures be undertaken "to his satisfaction". They have also been critical of what they perceive to be a breakdown of the "one window" approach to regulation of the industry, and they have complained that the industry now has to deal with a number of inspectors and overlapping jurisdictions.

To address these concerns, the Yukon Territory Water Board developed and presented for public review at hearings held in September and October of 1979. Interim Guidelines for Authorization to Use Water for the Purpose of Placer Mining in the Yukon Territory. These guidelines included a stream classification system that was vaguely similar to the present proposed guidelines with the very notable difference that there were no effluent standards included in the document. The Board had intended to include such standards but it could not determine what these standards should have been.

The public hearings revealed that the interim guidelines were generally supported by Government and roundly opposed by the placer mining industry. While supporting the guidelines, Government called for more stringent conditions, the most controversial of which was a suspended solids effluent standard of 100 milligrams per litre (mg/l) above background.

The KPMA stated that the guidelines would be "devastating" to the industry, that they were being introduced too quickly, and that more evidence was required to back up the rationale for the restrictions and standards contained in the guidelines. They concluded their remarks to the Board by stating that the industry would rather operate under the 1975 guidelines.

The interim guidelines were never implemented. In December 1979 the Yukon Territory Water Board informed the Minister of DIAND that it could not develop or implement guidelines until the Minister provided policy direction and a legislative framework.

To date no such policy direction or legislative framework has been provided by the Minister and the 1976 guidelines are still in effect. The concerns and criticisms expressed by Government and industry about the 1976 guidelines remain basically unchanged. The present proposed guidelines attempt to address these concerns and criticisms.

1.4 Government/Industry Consultation

Consultation between Government and the placer mining industry dates back to the early 1970's. At that time the consultation was between the Yukon Territory Water Board and a loosely organized industry association which was the forerunner of the Klondike Placer Miners Association (KPMA). This consultation took the form of public hearings held, for the most part, in Dawson City.

In 1975 the Water Board developed a set of water use guidelines for placer mining and implemented them during the 1976 season. These guidelines are presently in use today.

The next major effort at consultation was the public hearings held by the Water Board in 1979 to review new guidelines developed and proposed by the Water Resources section of DIAND, the government and

the industry. The KPMA, a very vocal participant in these hearings, was officially constituted in 1979; a fact that was in no small way precipitated by the efforts of Government to introduce new guidelines.

After the 1979 hearings, consultation between Government and the industry continued. The hearings revealed that more scientific information was needed on such issues as the effect of placer mining effluent on fish, the rehabilitation of mined areas and the general environmental impacts of placer mining. The Placer Environmental Studies Technical Committee (PEST Committee) was struck to act as a steering committee which would commission and oversee a number of studies to provide this information. This Committee included representatives of DOE, DFO, DIAND and the KPMA. Four reports were prepared under the auspices of this Committee:

> Aquatic and Wildlife Resources of Seven Yukon Streams Subject to Placer Mining (Mathers, West and Burns) funded by DIAND, DOE, DFO;
> Fish and Wildlife Habitat Recovery in Placer Mined Areas of the Yukon (Hardy Associates (1978) Ltd.) funded by DIAND, KPMA;
> Water Use Technology for Placer Mining Effluent Control (Sigma Resources Consultants Ltd.) funded by DIAND; and
> A Comparative Study of the Use of Disturbed and Undisturbed Areas by Wild Vertebrates in the Klondike, Yukon Territory (C.C. Hawley and Associates, Inc.), funded by the KPMA.

The PEST Committee was disbanded in January 1982.

Since 1979 there have been a number of meetings between Government and the industry to review discussion papers and to present their respective positions. The last of these meetings were held in January and February of 1982.

The next phase of consultation will be public hearings to review the proposed guidelines. Copies of the proposed guidelines will be available to all placer miners and interested parties in advance of the hearings, which are expected to be held in late spring of 1983.

1.5 Requirement of a Socio-Economic Impact Analysis (SEIA)

Government of Canada policy requires that major new regulations or amendments to existing regulations relating to health, safety, or fairness (HSF) be subjected to socio-economic impact analysis.

> "This policy is intended:
> (a) to promote a more thorough and systematic analysis of the socio-economic impact of new HSF regulations in order to improve the allocation of resources and the information available to the decision-making process on other socio-economic factors (i.e. the federal government is concerned not only with the impact of HSF regulations on market efficiency, but also with their impact on the distribution of income, regional balance, technological progress, market structure, balance of payments, output, employment, and inflation);
> (b) to ensure uniformity, among the departments and agencies currently administering statutes which confer the power to make regulations in the HSF area, in the methodologies and assumptions used to perform such analyses; and
> (c) to provide an opportunity for increased public participation in the regulation-making process."
>
> (Chapter 490 Administrative Policy Manual)

It should be noted that in their present form the proposed guidelines are not actually regulations but it is clear that they may form the model for whatever regulations are eventually drafted. Therefore, in the context of this SEIA, these guidelines are being treated as if they were regulations.

The proposed guidelines for the Yukon placer mining industry clearly meet the criteria established to determine the applicability of the SEIA policy: the guidelines are being sponsored by DIAND, DFO and DOE which are the departments to which the policy applies; the guidelines relate to health, safety and fairness since they concern the protection of the environment; and, the guidelines represent major new regulations because they will have important implications for the Yukon placer mining industry and because they are directed specifically to the placer mining industry.

CHAPTER 2

YUKON PLACER MINING INDUSTRY

2.1 Present Regulatory Regime and Administration

The Yukon placer mining industry is directly regulated by two pieces of legislation: the Yukon Placer Mining Act (YPMA) and the Northern Inland Waters Act (NIWA). For many years the YPMA regulated the use of water by placer miners. However, when NIWA was promulgated in 1972, those sections of the YPMA governing the use of water were revoked and the NIWA then became the legislation governing the use of water.

It should be noted that the Fisheries Act also regulates the use of water by placer miners: Section 20 governs the construction of fishways (fishways to be made as fishery officer directs); Section 31 prohibits the harmful alteration, disruption of destruction of fish habitat; and, Section 33 prohibits the release of substances deleterious to fish in Canadian waters unless permitted by regulations under the Fisheries Act or some other act. To date, no such regulations have been enacted, so that, it can be said that the placer mining industry is also directly regulated by the Fisheries Act.

For the purposes of this study, we are concerned with the day-to-day regulation of the industry, as determined by the NIWA and the Fisheries Act through the Yukon Territory Water Board and the office of the Controller of Water Rights.

a) Yukon Territory Water Board

Section 9 of the NIWA established the Yukon Territory Water Board:

> "to provide for the conservation, development and utilization of the water resources of the Yukon Territory ... in a manner that will provide the optimum benefit therefrom for all Canadians and for the residents of the Yukon ... in particular."

The Board has the power, subject to the approval of the Minister of DIAND, to issue licences for the use of water and to attach to such licences any conditions that it considers appropriate. However, the Board cannot set conditions that are less stringent than those set by the Governor-in-Council.

The Board at present does not review applications for water use permits from all placer operations, only those (licences) that are very large or those that may have very significant environmental impacts. The vast majority of placer operators are issued water use authorizations by the Controller of Water Rights. This practice was instituted about ten years ago when it became clear that it was administratively impossible for the Board to review every application for a water use licence.

The Water Board's major day-to-day regulation of the industry is effected through the guidelines it developed in the mid-1970's (Appendix III), which are the guidelines that currently govern the industry. These guidelines are very general in nature and cover such matters as the use of settling ponds, measures to be taken to protect fish stocks and other water users, the stabilization of tailings, the circumstances under which an applicant is required to prepare an environmental impact statement, and the circumstances under which a placer operation is required to have a water use licence rather than an authorization.

b) The Controller of Water Rights

The Controller is responsible to the Minister of DIAND and is empowered to issue an Authorization to Use Water Without a Licence or simply "an authorization", subject to Section 11 of NIWA regulations. The office of the Controller is the regulatory arm of the NIWA and has the most frequent dealings with the placer mining industry. Virtually all applications, either for a licence or for an authorization, are initially received by the Controller. Those applications that may

require a licence are referred by the Controller to the Water Board and those that meet the criteria of section 11 of the regulations of the NIWA are reviewed by the Controller; that is, they are for a short period of time (less than 270 days) or the rate of water use is less than 50,000 gallons per day (189270 litres/day).

Existing operators must renew their authorizations every year. This is a simple procedure and only requires that an applicant file an application for renewal which details only the most basic information about the nature of the operation and the quantity of water to be used. If the Controller is satisfied that no major alteration in the scope or nature of the operation is being proposed, and if the operator has in the past met the conditions attached to his authorization, then a renewal will be issued.

In addition to an application for an authorization, new operators and those operators whose plans are out of date are required to submit an Information Sheet for Water Use Application. This document provides detailed information on the location of the mine, background data on the water sources, how water is to be used in the mining process, the mine site plan, the design and use of dams and diversions, the disposal of tailings, mine wastewater treatment and camp waste, the storage of fuel and site rehabilitation. The application is reviewed and approved by the Controller. Factors to be considered during the review of the application are the layout of the settling ponds, the stability of any planned diversions and generally how water will be acquired, used and treated.

The Controller attaches specific operating conditions to all the authorizations. Such conditions might include: the provision of settling facilities, the provision of passage ways for fish, the maintenance of stream flow, the contouring of tailings, prohibition of certain practices such as ground sluicing and the use of automatic gates, and other performance criteria.

It should be noted that part of the Controller's review of an application usually includes referring it to the Department of Fisheries and Oceans (DFO) for their comment and suggestions. Some of the conditions that the Controller may attach to an authorization may be designed to address deficiencies or weaknesses identified by DFO to be specific fisheries concerns (i.e. fish passage facilities).

Even if it is not always required, authorizations may not be issued until a site inspection by officials of the Water Resources section of DIAND has been completed. The purpose of this inspection is to ensure that the applicant has satisfactorily completed the work outlined in his application, including whatever work might be required to meet the conditions attached to his authorization.

c) Role of the inspector

Inspection of placer operations is presently being carried out by a staff of five Water Management Officers (WMO) (based on 1982 season); two in the Dawson area, one in the Mayo area and two to cover the rest of the Yukon from the Whitehorse office of DIAND. The WMO's have been designated as Water Use Inspectors under Section 29 of the NIWA. The inspector has several roles to play. As an enforcement officer, he performs periodic inspections to ensure compliance with the guidelines and with the conditions attached to the authorizations approved by the Controller. As an adviser, he tries to provide members of the industry with information and advice that may enable them to more effectively and efficiently meet the requirements of both the guidelines and the Controller. As an arbitrator, he handles disputes among operators that may arise over water supply, flooding, encroachment and other areas of conflict.

The present guidelines put the inspector in a very difficult position. As mentioned before, these guidelines are couched in very general and purposefully non-specific language. It is up to the inspector to decide if settling ponds have been constructed "to the

satisfaction of the Controller", or if the conditions of the authorization have been met. The placer mining industry has always been very critical of the discretionary power given to the Controller and his inspectors by the present guidelines. To wield this power effectively, the Controller and the inspectors must exercise a generous amount of tact and good judgement.

2.2 Importance of Placer Mining

The Yukon's economy is, to say the least, heavily dependant on the mining sector. The Yukon Government's Economic Research and Planning Branch (ERPB) estimates that mining (hardrock, placer and exploration) accounts for about 65 to 70 percent of the Gross Territorial Product (GTP - as estimated by ERPB, excludes transfer payments).

The industry's direct contribution to GTP is estimated to be between 20 and 35 percent (including placer mining). The assumption has been made that placer mining contributed 10 percent of the contributions made by the mining sector (ERPB). If this assumption holds then it can be said that placer mining has made a direct contribution in 1981 of between 2.0 and 3.5 percent.

To illustrate the relative importance of placer mining to the economy of Yukon, it is interesting to note that it has been estimated (DIAND) that the placer gold produced in 1980 was almost equivalent in worth to the value of the total production of United Keno Hill Mines (UKHM) and twice the value of the total production of Whitehorse Copper Mine. After adjusting for placer gold not declared or yet to be declared in 1980, it was estimated that the value of production was $52 million while the production of UKHM was $58.8 million and Whitehorse Copper was $26 million (G. Gilbert, DIAND, Whitehorse, Y.T.).

For many years placer mining has represented a relatively small component of mining's contributions to GTP. Over the last five years, however, the rising price of gold has given new life to the industry and it has now become a significant element of the Yukon's economy in its own right. Table 2.1 illustrates the growth of the industry during the last five years. It should be noted that the figures provided are for royalty paid gold. Since royalties are not always paid on the gold that has been produced, these figures do not provide a precise measure of gold production activity from year to year. In years of relatively high gold prices these figures would probably tend to overestimate production while the reverse would be true in years of low gold prices.

Table 2.1 also shows that Yukon produced, for the 1976-1981 period, between 2 and 7 percent of all gold produced in Canada. Moreover placer mining has contributed from 60 to 92 percent of gold produced in Yukon Territory for some time. Thus, this means that placer mining has been responsible for between 1 and 6 percent of all Canadian gold production.

There has also been a marked change in the nature of placer mining during this time as well (last five years). Once regarded as basically a "family-run" business, placer mining has now seen the entry of larger operators using larger crews and more equipment, with greater operational capacities.

a) Recent developments

In 1982 the Yukon mining industry was severely affected by the collapse of world metal prices. Two of the three operating hardrock mines were shut down for half of the year, while the third announced plans for a permanent closure at the end of the year. Placer mining has also suffered during this time. However, the effect was not as pronounced and with an improvement of gold prices during the second

TABLE 2.1 YUKON'S GOLD PRODUCTION - In Troy Ounces

YEAR	Canadian Gold Production	Yukon Gold Production[a]	Placer Mining Production[b]	Placer Mining Value (Million $)
1976	1,691,808	35,754	21,312	2.6
1977	1,733.611	32,990	25,692	4.0
1978	1,740,871	38,654	25,780	5.7
1979	1,644,000	38,272	35,076	12.6
1980	1,552,000	95,884	73,026	52.3
1981	1,591,640P	115,627	99,800	55.0

p Preliminary

a Includes hardrock.

b Royalty-paid gold expressed in Troy Ounces.

Source: Mining Recorder, DIAND, Whitehorse, Yukon.
: Mineral Policy Sector, Energy, Mines and Resources Canada
: Statistics Canada
: Northern Resources and Economic Planning, DIAND, Ottawa

half of the year, placer mining became one of the few relatively bright spots in the mining sector and the economy as a whole.

Preliminary estimates for 1982 indicate that there has been a reduction in placer mining activity of about 33 percent (ERPB). The number of water use authorizations has risen from 318 in 1980, to 339 in 1981, and 348 in 1982 (DIAND). This increase in water use authorization is mainly related to the increase in exploration and assessment, based on placer miners expectations that for the next few years, a bull market for gold will occur. Figures provided by DIAND (Mining Recorder) indicate that royalties were paid on 73,641 troy ounces of gold during 1982. This represents a 35.5 percent decrease in royalty paid gold over the same time in the previous year.

b) Aesthetic value to Canadians

For those seeking wilderness and enjoyment of outdoor recreation, placer mining and its inherent and associated disturbance of the environment clearly represents a cost. Yet, the history for the Klondike gold rush is intricately woven into the fabric of tourism in Yukon. Every year thousands of tourists visit the Dawson City area. Placer mining for them can be said to have a positive effect on aesthetic values in the sense that it is "interesting". Officials from the Department of Tourism, Heritage and Cultural Resources of the Government of Yukon report that there is some demand by tourists for more access to and interpretation of the placer mining activities in the Dawson area.

2.3 Gold Production and Prices

As stated previously, it is extremely difficult to determine the exact production of gold that comes from the placer mining industry. The only way to estimate this is to look at the royalties that have been paid on gold; Table 2.2 shows the number of Troy ounces

TABLE 2.2 ROYALTY PAID PLACER GOLD

YEAR	TROY OUNCES
1971	5,493
1972	5,293
1973	8,509
1974	12,136
1975	19,378
1976	21,312
1977	25,692
1978	25,780
1979	35,076
1980	73,026
1981	99,800
1982	73,641

SOURCE: M.E. Miller & Associates Ltd., Impact on the Yukon Economy of the gold placer mining industry 1980, prepared for the Klondike Gold Placer Miners Association, February 1981.

: personal communications, Mining Recorder's office.

on which royalties have been paid. When these data are plotted on a graph (Graph 2.1) gold production is seen to have risen steadily over the last decade.

Graph 2.2 illustrates variation in the price of gold during the same period (1972-1981). Using the information on these graphs plus figures for the 1976-81 period as prepared by EPRB of the Yukon Government (Economic Research and Planning Branch, Government of Yukon, Average U.S. dollar value of gold and value of the Canadian dollar), the average value of gold for the years 1972-1981 can be determined. Table 2.3 presents the average value of gold for the years 1972-1981 based on current U.S. dollars. To express these values in 1981 U.S. dollars, the Consumer Price Index for each year has been applied to determine the rate of inflation. These values are presented graphically in Graph 2.3.

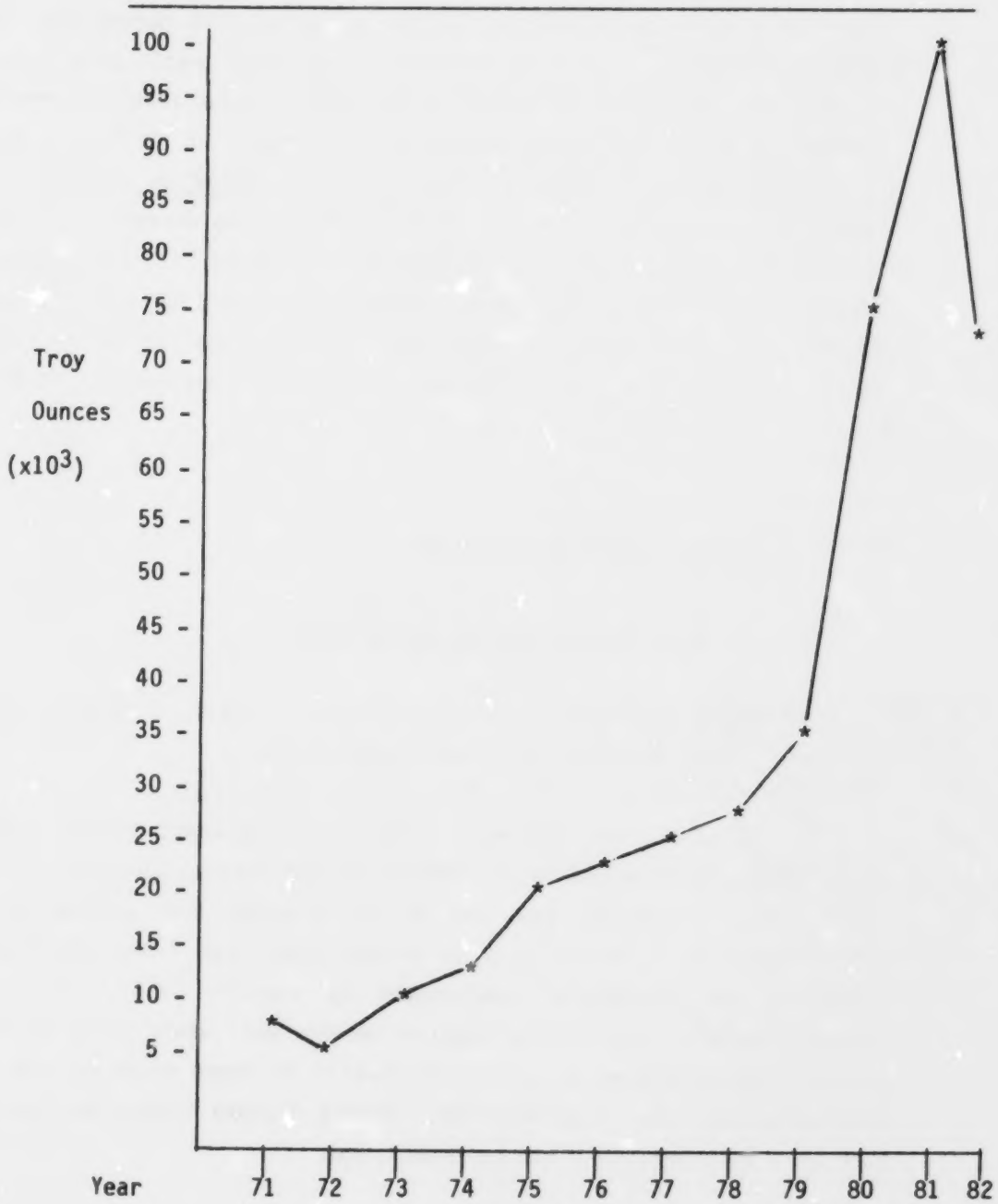
2.4 Current Industry Structure

a) Geographical/geological setting

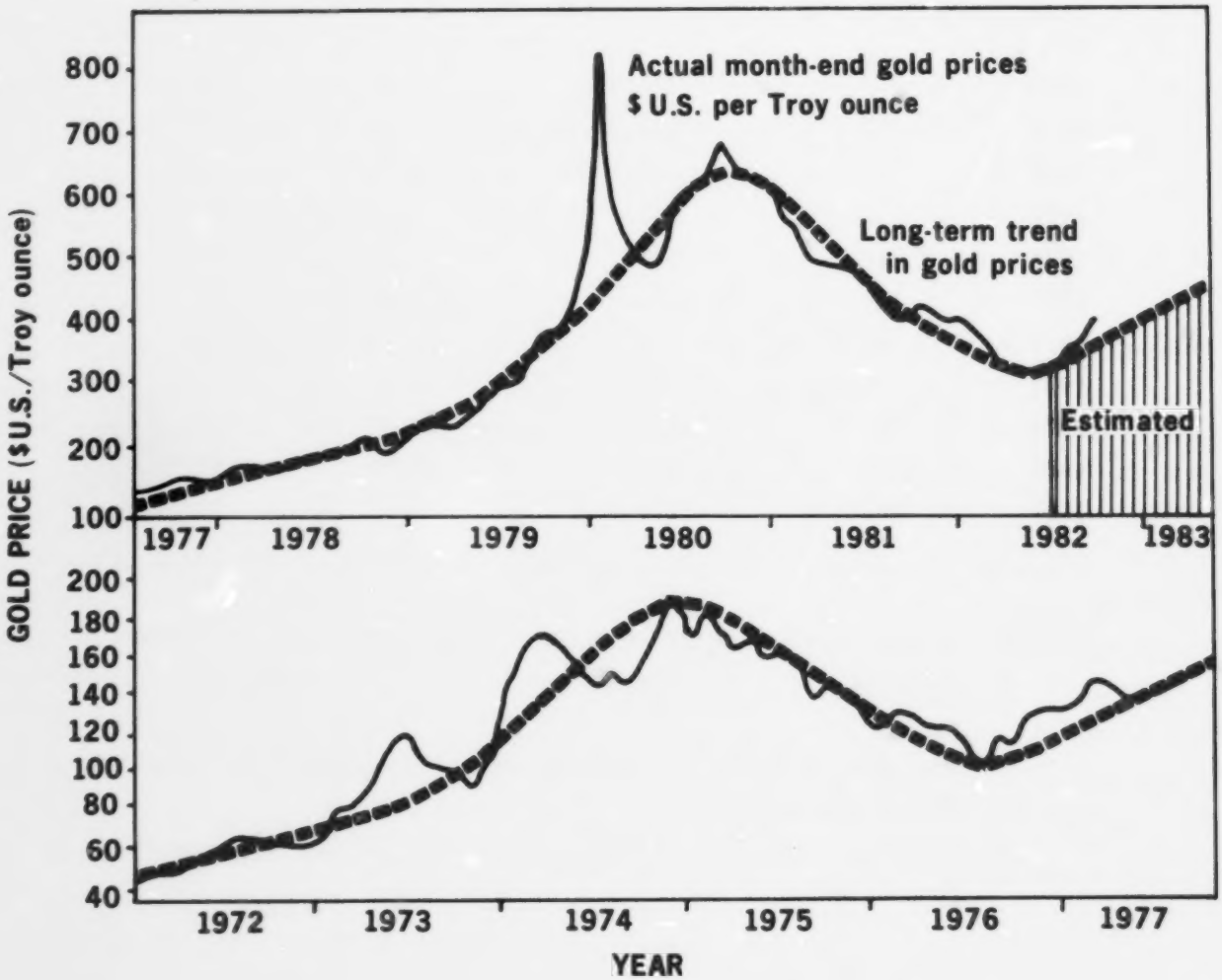
There are three major placer mining areas in Yukon. These are Dawson, Mayo and Burwash. (See Figure 2.1)

At this time, the most accepted theory about placer genesis states that placer deposits are formed by the natural concentration of heavy minerals during the course of erosion and weathering of mineralized rock. As the rock is broken down, the finer and lighter fragments are transported downstream by run-off water, while the heavier minerals tend to sink towards bedrock and remain close to their source. Coarse pieces of gold will usually be found close to the rock from which they have been detached. Finely divided flakes and dust may turn up a considerable distance downstream.

GRAPH 2.1 PRODUCTION OF GOLD 1972-1982



GRAPH 2.2 PRICE OF GOLD 1972-1982



Source: Richardson Greenshield of Canada Ltd. 1982

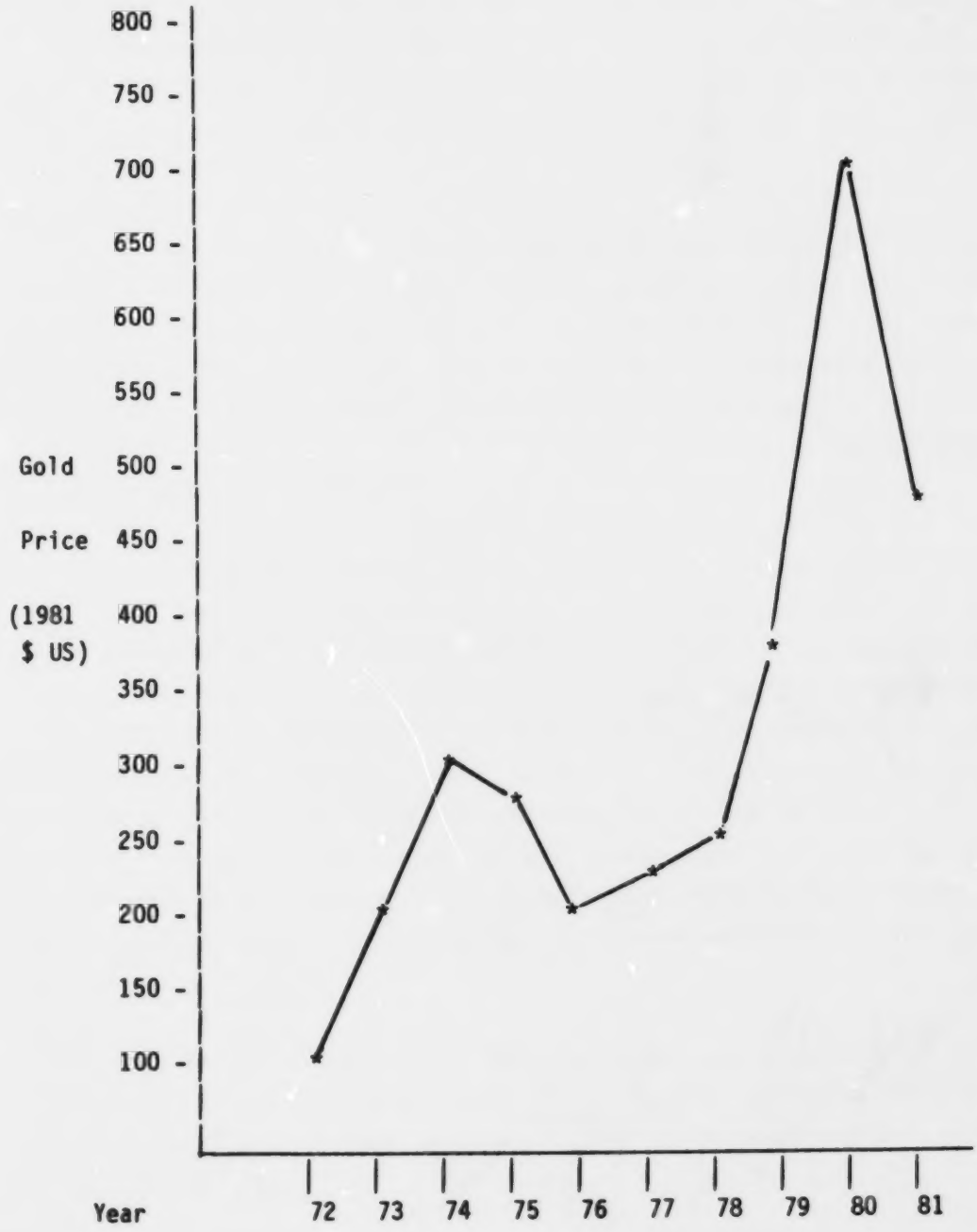
TABLE 2.3 PRICE OF GOLD IN CURRENT AND 1981 U.S. DOLLARS

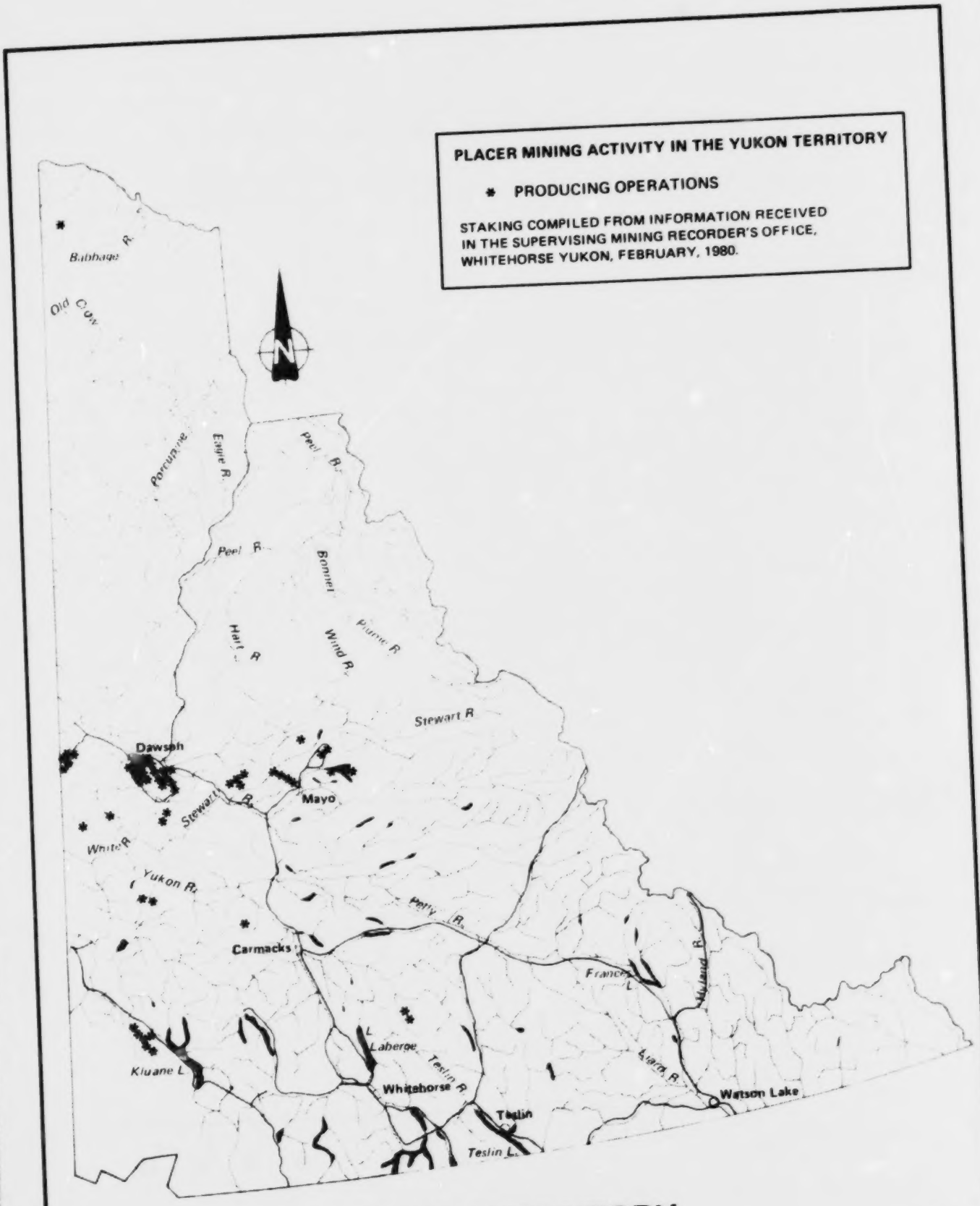
YEAR	PRICE CURRENT U.S. $	U.S. CONSUMER PRICE INDEX	U.S. INFLATION*	PRICE 1981 U.S. $
1971	-	121.3	8.4%	-
1972	50	125.3	9.0%	109
1973	100	133.1	9.4%	205
1974	155	147.7	9.1%	285
1975	160	161.2	9.1%	270
1976	125	170.5	9.8%	199
1977	148	181.5	10.7%	222
1978	193	195.3	11.7%	269
1979	307	217.7	11.8%	384
1980	613	247.0	10.2%	675
1981	460	272.3	_	460

SOURCE: United States Department of Commerce/Bureau of Economic Analysis.

* The rate of inflation is the annual compound rate from the chosen year to 1981.
Examples from 1974 to 1981 the inflation was 9.1% per year compounded.

GRAPH 2.3 PRICE OF GOLD 1972-1981, in 1981 U.S. $





YUKON TERRITORY

SCALE 1:5,000,000

FIGURE 2.1

Placer deposits in Yukon are usually creek or bench deposits. A bench deposit is formed by a meandering stream which, having deposited its load of gravel -- usually against a bank, then cuts its channel deeper and deeper leaving the gravel high and dry in the valley wall some distance above the surface of the water. Typically, the richest gravels are those closest to bedrock. In a few isolated cases, all the gold lies in cracks in the bedrock with none in the gravels. In extreme cases, placer gold has penetrated 12 feet into highly fractured bedrock.

While this part of the geological explanation for placer deposits is quite well accepted there is much controversy about the relationship between glaciation and placer deposits. It is well known that during the Pleistocene, many of the Yukon's valleys were heavily glaciated. These ice sheets were not continuous and their effects on previous sedimentary deposits -- like placer deposits -- varied from place to place.

There is a popular notion that valley glaciation may have destroyed any placer deposits in its path, so that, placer deposits will be found only in unglaciated valleys. This notion is used to explain the existence and predominance of the Klondike gold fields which are said to have resulted from two facts: the presence of long since eroded gold-bearing quartz veins acting as a source, and the absence of glaciation in the northwestern part of the Territory. This notion, however, does not stand up well under empirical analysis, for of the four major placer areas in or near Yukon (Dawson, Mayo, Burwash, Atlin), only the Dawson area has extensive ground that was not glaciated.

The following table, prepared from data supplied by the Supervising Mining Recorder, DIAND, Yukon and from estimates from "The Atlin Mining Camp" (author unknown), allows us to compare placer gold production by area.

TABLE 2.4 PLACER GOLD PRODUCTION IN YUKON RIVER BASIN

	PLACER GOLD PRODUCTION 1969 to 1981	
	TROY OUNCES	PERCENT OF PRODUCTION
Dawson	248,410	65
Whitehorse (includes Burwash)	92,336	24.2
Mayo	9,010	2.4
Watson Lake	240	0.0
Atlin, B.C.	32,000	8.4
Total	381,996	100.00

SOURCE: Memo to file prepared by W.G. Whitley, Director, Yukon River Basin Study, October 5, 1982.

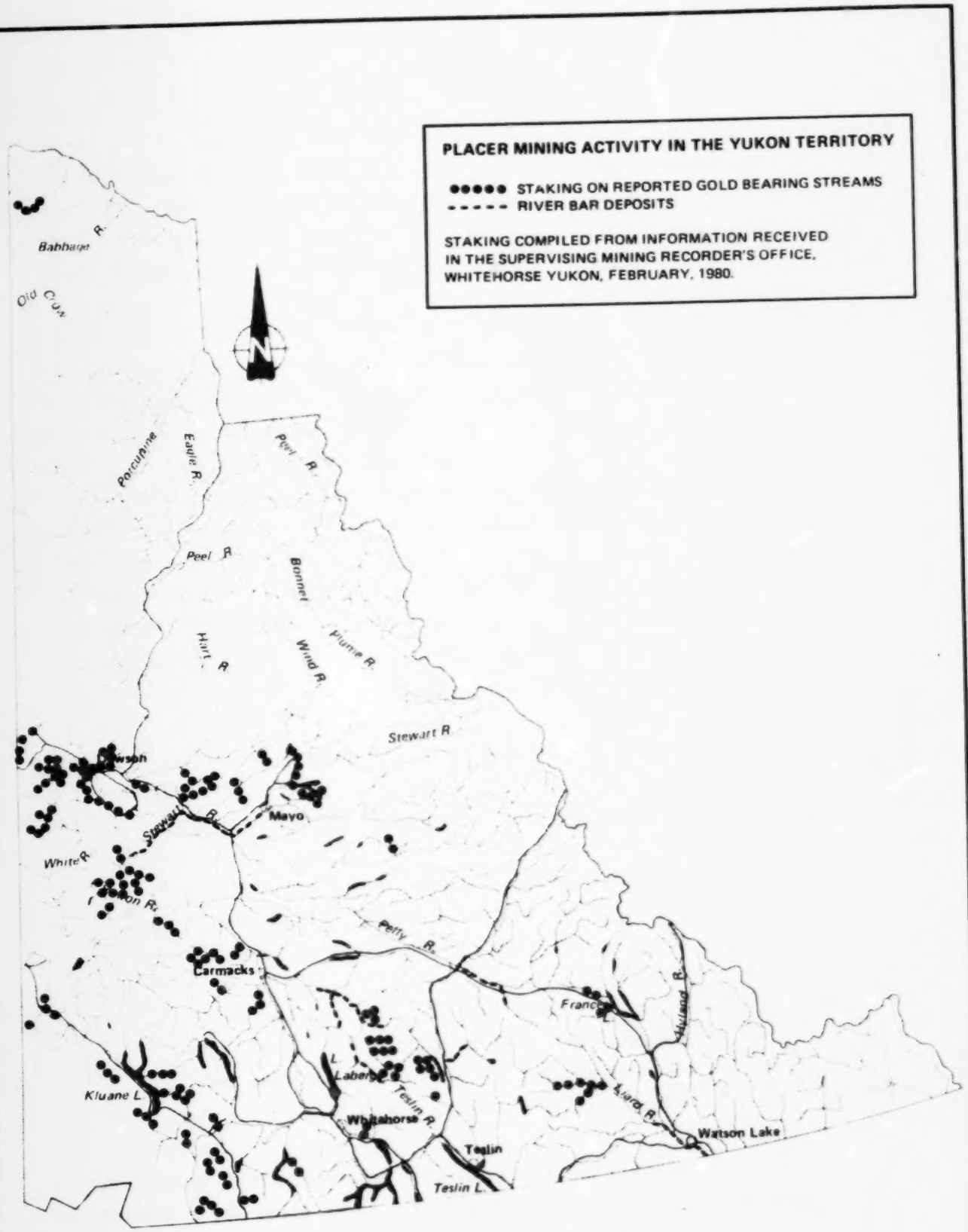
From this table it can be seen that 35 percent of the placer gold produced between 1969 and 1981 came from glaciated areas (Atlin, B.C., Burwash, Mayo). However, it should be noted that Table 2.4 lists gold received by Mining Recorders in the areas listed and this is not necessarily indicative of the area's production (e.g. many miners carry the gold to Whitehorse).

In summary, there are two main ways of thinking about the occurrence of placer deposits. The first states that they are very localized and quite well known. The second believes that placer activity could be spread more widely throughout Yukon Territory - this is illustrated by recent observations that when the price of gold reached its highest peak, valleys never before considered were claimed and mined. There is also a possibility that a new geological theory will emerge so that even more new areas might be considered interesting from a placer mining point of view. This is convincing evidence that placer gold is not limited to unglaciated areas and lends credence to the old adage that "gold is where you find it".

It could be concluded from the above observation that there are large areas of undiscovered placer ground still available for staking in the Yukon, however, as noted in Yukon Placer Mining, a DIAND publication,

> "Most of the areas, however, which have a potential for placer gold deposits have been examined and staked, often several times,"
> and
> "While it cannot be said that no new gold-bearing areas will be found in Yukon, it must be realized that the possibility becomes more remote with each passing season."

Figure 2.1 shows the location of placer mining gold producing operations (1980). Moreover Figure 2.2 shows areas where exploration



YUKON TERRITORY

SCALE 1:5,000,000

FIGURE 2.2

and assessment have been undertaken. These areas are those which may be exploited in the foreseeable future. The extent of the exploitation is, however, heavily dependent on the trend of the price of gold in the next few years.

b) Employment

It has been estimated (ERPB) that placer mining provided 2.2 percent of all full time man years of employment in Yukon in 1981. Using an employment multiplier of 1.5 for the placer mining industry (ERPB), it can be estimated that placer mining accounted for 3.3 percent of all man years of employment in Yukon in 1981. It has also been estimated (ERPB) that the industry directly and indirectly contributed up to 4 percent of the salaries and wages earned in the Yukon in 1981. Table 2.5 shows the direct employment created by the placer mining industry.

c) Operating costs and expenditures: The Miller Report

To date there has been little data available with which to attempt some measurement of the impact of placer mining on the Yukon economy. The only published attempt has been Impact on the Yukon Economy of the Gold Placer Mining Industry 1980 prepared by M.E. Miller and Associates Ltd. for the Klondike Placer Miners Association. The methodology used involved interviewing a representative cross-section of placer mine operators who operated during the 1980 season and securing information from major suppliers that serviced the industry. Expenditures by the industry for goods, services and wages and benefits paid in the Yukon was used as the measure of the industries impact on the economy.

The 197 operating placer miners in actual production in 1980 were divided into three categories: single operators, medium companies (2-9 employees), and larger companies (more than 10 employees). There were 81 single operators (41 percent), 101 medium companies (51 percent) and 15 larger companies (8 percent). From the cross-section of

TABLE 2.5 DIRECT EMPLOYMENT FROM PLACER MINING

YEAR	MAN YEARS [a]
1978	140[b]
1979	-
1980	329[c]
1981	235[b]
1982	225[d]

SOURCE

a The number of jobs do not include the operator.

b Miller, M.E. & Associates Limited. Impact on the Yukon Economy of the Gold Placer Mining Industry. Prepared for the KPMA, February 1979, and February 1980.

c ERPB - Economic Research and Planning Branch, Department of Economic Development, Government of Yukon.

d Estimated from a note to file of gelogy section, DIAND, 1982 Employment in Yukon's Placer Mining Industry.

operators interviewed, Miller developed a list of "average" expenditures for a typical operator in each of the above categories. The list of expenditures is summarized in Table 2.6. By multiplying the average for each category by the number in each category and then summing these products, Miller has calculated the total impact of the industry on the economy in 1980; these findings are summarized in the Table 2.7.

d) Secondary impacts of the industry

The Miller report does not attempt to measure the total economic impact of the industry. However, some attempt was made to measure "identified" secondary impacts, that is, those sectors of the economy that Miller was able to identify as being directly linked to the placer mining industry. The secondary impacts were noted as in Table 2.8. Moreover Table 2.9 notes the total direct and "identified" secondary impacts of the industry. It was also noted that capital expenditures made outside of Yukon by the industry were approximately $13.8 million.

2.5 Future Development of the Industry

a) Gold production forecast model

Like all the other segments of the mining industry, the level of production from placer mining activity is very closely related to the current price of gold. But unlike the other metals, the price of gold cannot be correctly forecast by using econometric models, since gold does not only answer the law of supply and demand as a product, but it is also used as an investment (people and governments stock and/or sell large quantities of gold each year).

However, in order to assess the effect of the proposed guidelines on placer mining over the next few years, an attempt has been made to forecast what the level of placer mining under the current

TABLE 2.6 AVERAGE EXPENDITURE BY CATEGORY

	SINGLE OPERATOR	MEDIUM COMPANY	LARGE COMPANY
OPERATION AND MAINTENANCE			
Equipment and machinery repairs and maintenance	$ 9,035	$ 24,616	$ 246,575
Fuel and lubricants	4,633	27,136	215,000
Food and accommodation	2,073	8,025	66,250
Wages and benefits[a]	3,771	54,958	454,775
Other expenses	3,585	35,451	383,000
Total Operation and Maintenance Expenditures	$ 23,097	$ 150,186	$ 1,365,600
CAPITAL			
Equipment purchases	$ 18,221	$ 139,523	$ 1,214,000
Other capital expenditures[b]	159	16,020	76,250
Total Capital Expenditures	$ 28,380	$ 155,543	$ 1,290,250

a Does not include wages and benefits for owners.

b Includes pumps, pipes, steel, etc.

SOURCE: The Miller Report

TABLE 2.7 EXPENDITURES - 197 PRODUCING PLACER MINES

OPERATION AND MAINTENANCE	
Equipment & machinery repairs & maintenance	$ 6,916,676
Fuel & lubricants	6,814,114
Food & accommodation	1,972,188
Wages & benefits[a]	12,667,835
Other expenses	9,615,936
Total Operations & Maintenance	$ 37,986,749
CAPITAL	
Equipment purchases[b]	$ 34,587,724
Other capital expenses[c]	2,774,649
Total Capital Expenditures	$ 37,362,373
AVERAGE MONTHS OF OPERATION	5.1

a Wages and benefits do not include owner/operator salaries, wages of benefits.

b Equipment purchases do not include purchases outside of Yukon which are estimated at $14,000,000 during 1980.

c Other capital expenditures include pumps, pipes, conveyors, steel, housing, etc.

SOURCE: The Miller Report

TABLE 2.8 IDENTIFIED SECONDARY IMPACTS - 1980

Employees	141
Employment	130 man years
Wages/salaries	$2.5 million
Total operation and maintenance expenditures	$3.0 million
Capital expenditures	$2.0 million

SOURCE: Miller Report

TABLE 2.9 TOTAL DIRECT AND IDENTIFIED SECONDARY IMPACTS - 1980

Employees	929
Employment	459 man years
Wages/salaries	$15 million
O/M (includes wages/salaries)	$41 million
Capital expenditures	$39 million

SOURCE: The Miller Report

regime would be. Using the price of gold and the corresponding production for the 1972 - 1981 period, the purpose of this section is to attempt to establish a gross relationship between these two variables in order to forecast what the production of gold may be in the next few years. (Appendix IV) With the mathematical model developed and explained in Appendix IV, the following equation for gold production forecasting has been derived:

$$y = -18{,}392 + 180x$$

where y = placer gold production in troy ounces and x = the price of gold in 1981 U.S. dollars.

b) Development scenarios for the placer mining industry

With the establishment of a mathematical model, it is assumed possible to forecast the level of activity in the placer mining industry, assuming that we know what the price of gold will be. Forecasting the price of gold is difficult. The consensus in the financial community is that, at present, the best indicator is interest rates: interest rates rise the price of gold falls and vice versa. Despite this consensus forecasting, even short term forecasting, is guesswork at best. To illustrate this, consider a recent newspaper article (Les Affaires, Sep. 18, 1982) in which one member of the financial community forecast that the price of gold could be somewhere between $335 and $650 per ounce by the end of 1982. With such a wide range for such a short term (from September to December), it is obvious that long range forecasting is virtually impossible.

It is interesting, however, to consider what the financial community is forecasting for the price of gold. From the same newspaper article noted above, two experts offered their thoughts on the matter. According to M. John Hartmann, Vice-president of Fiducie Guardian in Montreal, there are two major factors to consider: (1) the level of fear that will hit the international monetary system and (2) the interest rate. According to him, the bankruptcy of a major bank could raise the price of gold by $200/ounce in a few days. However, if

the international banks can reach an agreement with the developing countries, the price could fall to around $330 U.S.

M. Sam McAvity, editor of the financial letter "Deliberation", believes that the price of gold will continue to rise for a while; the recent rise is to him "the first leg in a bull market". According to him, the summit of the rush should occur between 1984 and 1986 and the price could jump to $3,000 U.S. His forecast is based on a technical study of stock and gold cycles (Charles-Edouard Lebel for Les Affaires Sep. 18, 1982).

To the previously mentioned factors that determine the price of gold we should also add the "world anxiety index" which is related to the world geopolitical stability and also the sales or lack of sales by the USSR and other communist countries as determined by their need for foreign currencies. In sum, the only confident statement that can be made about the price of gold is that no one knows what the price of gold will be next week!

Since it is not possible to forecast the price of gold and since such a forecast is necessary to assess the activity level of placer mining for the 1983-1995 period, an attempt has been made to estimate a reasonable range into which the price of gold would likely fall during the next 13 years. Those estimates are based on a review of recent financial newspapers. As a lower level, the price of gold is assumed to be $330 (1983 U.S.); this is termed the "low gold price scenario". The "high gold price scenario" assumed a price of gold of $700 (1983 U.S.). It has been assumed that the price of gold in the period 1983-1995 may fall between those two limits throughout the forecast period.

Now that limits of the range have been chosen, it is possible to assess the production by using the mathematical model. However, that model is only valid when prices are expressed in 1981 US dollars and this has been accomplished by using a 10 percent inflation rate per

year (which approximates the US inflation rate during the last two years). Accordingly, the low gold price becomes $272 US (1981 dollars) and the high gold price becomes $579 US (1981 dollars). With these prices the annual gold production from placer mining is calculated to be:

$$y = -18,392 + 180X$$

So for $x = \$272$ $\quad y = 30,568$ ounces

and for $x = \$579$ $\quad y = 85,828$ ounces

c) Future placer mining incomes

To estimate future placer mining incomes, it is necessary to consider the estimated gold production associated with the two scenarios, (as expressed in US dollars) and the equivalent price of gold in Canadian dollars. An exchange rate of 0.80 US dollars for 1.00 CDN dollar has been assumed. Under the low gold price scenario, one troy ounce will be priced at $330 US which is $412.50 CDN. From the mathematical model it is estimated that at this price the production of placer gold will be 30,568 troy ounces. This represents a total income of $12.6 million. Under the high gold price scenario, one troy ounce of gold will be priced at $700 US which is $875 CDN. At this price the production of placer gold will be 85,828 troy ounces which represents a total income of $75 million. Table 2.10 illustrates the production of gold and the associated income for each scenario.

d) Present value of future placer mining incomes

With these estimates of the annual income for the placer mining industry under each scenario, it is now possible to calculate the present value at discount rates of 5, 10 and 15 percent of these incomes for the 1983 - 1995 period. These present value estimates are summarized in Table 2.11.

The choice of a 13 year period has been made for the following reasons and is explained more clearly in Appendix VII:

TABLE 2.10 ESTIMATION OF YUKON PLACER GOLD PRODUCTION

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
- price of gold in 1981	$ 272 (U.S.)	$ 579 (U.S.)
- price of gold in 1983 US $	$ 330 412	$ 700 875
- production of gold in troy ounces	30,568	85,828
- gold production per year in 1983 CDN $	$ 12.6 million	$ 75 million

TABLE 2.11 PRESENT VALUE OF FUTURE YUKON PLACER GOLD PRODUCTION

	LOW GOLD PRICE SCENARIO (million 1983 CDN $)	HIGH GOLD PRICE SCENARIO (million 1983 CDN $)
Annual gold production	$ 12.6	$ 75.0
Present Value 1983 - 1995		
a) discount rate 5%	$ 124.3	$ 739.7
b) discount rate 10%	$ 98.5	$ 586.0
c) discount rate 15%	$ 80.9	$ 481.5

1. After 13 years, the present value of an annuity, when discounted at a rate of 10 percent, has reached 70 percent, the value that it would have been after an infinite period.
2. Forecasting price of gold, even with a scenario approach, for a longer period seems to be unrealistic.

e) Future employment

To evaluate the number of jobs that whould be created under each scenario, trends in employment have been considered. The high gold price scenario states that gold would have an average value of $700 (US 1983), at which price the placer mining industry would be in a "boom" situation. The last time that such a boom occurred was in 1980 and statistics for that year show that placer mining activity provided 329 man years of employment. It has been assumed, therefore, that under the high gold price scenario the direct employment contributed by placer mining would be between 300 and 350 man years. The low gold price scenario shows a gold price of $330 (US 1983); that price expressed in 1981 dollars is $272 (US 1981). According to the figures in Section 2.4, the last time the price of gold was at this level was in 1978 ($261 US 1981), at which time the direct employment in placer mining was 140 man years. So under the low gold price scenario, it has been assumed that placer mining activity would create between 125 and 150 man years of employment each year.

If an employment multiplier (See Appendix V - multiplier) of 1.5 for the placer mining industry is applied, the total employment created under each scenario would be as shown in Table 2.12.

f) Future impacts on Yukon

By using the 1.4 multiplier (see Appendix V), an assessment of the secondary impact of placer mining on the Yukon economy under each scenario can be made. The results of this assessment are presented in Table 2.13.

TABLE 2.12 FUTURE EMPLOYMENT IN YUKON PLACER MINING INDUSTRY
(annual man-years)

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
Direct Employment	125 - 150	300 - 350
Indirect Employment	63 - 75	150 - 175
TOTAL EMPLOYMENT	188 - 225	450 - 525

*Employment being expressed as man years/year.

TABLE 2.13 PRESENT VALUE OF FUTURE SECONDARY IMPACT OF YUKON PLACER MINING INDUSTRY

	LOW GOLD PRICE SCENARIO (million 1983 CDN $)	HIGH GOLD PRICE SCENARIO (million 1983 CDN $)
- Secondary impact in 1983 CDN $ (per year)	5.0	30
- Present Value (1983-1995)		
a) discount rate 5%	49.7	295.9
b) discount rate 10%	39.3	234.4
c) discount rate 15%	32.3	192.6

CHAPTER 3

THE YUKON FISHERY

3.1 Fish Resources of Yukon

The Yukon Territory supports an interesting variety of fish species, largely due to the geographical diversity of the land. Four different watersheds can be identified:

- The Yukon River basin, which drains into the Bering Sea;
- the Alsek-Tatshenshini system, which flows into the Gulf of Alaska;
- various rivers along the north coast which feed directly into the Arctic Ocean; and,
- river systems like the Liard, and the Peel which comprise part of the Mackenzie River basin.

As the variety of fish species in each of these four areas is slightly different, the resulting mix of species within Yukon is quite unique.

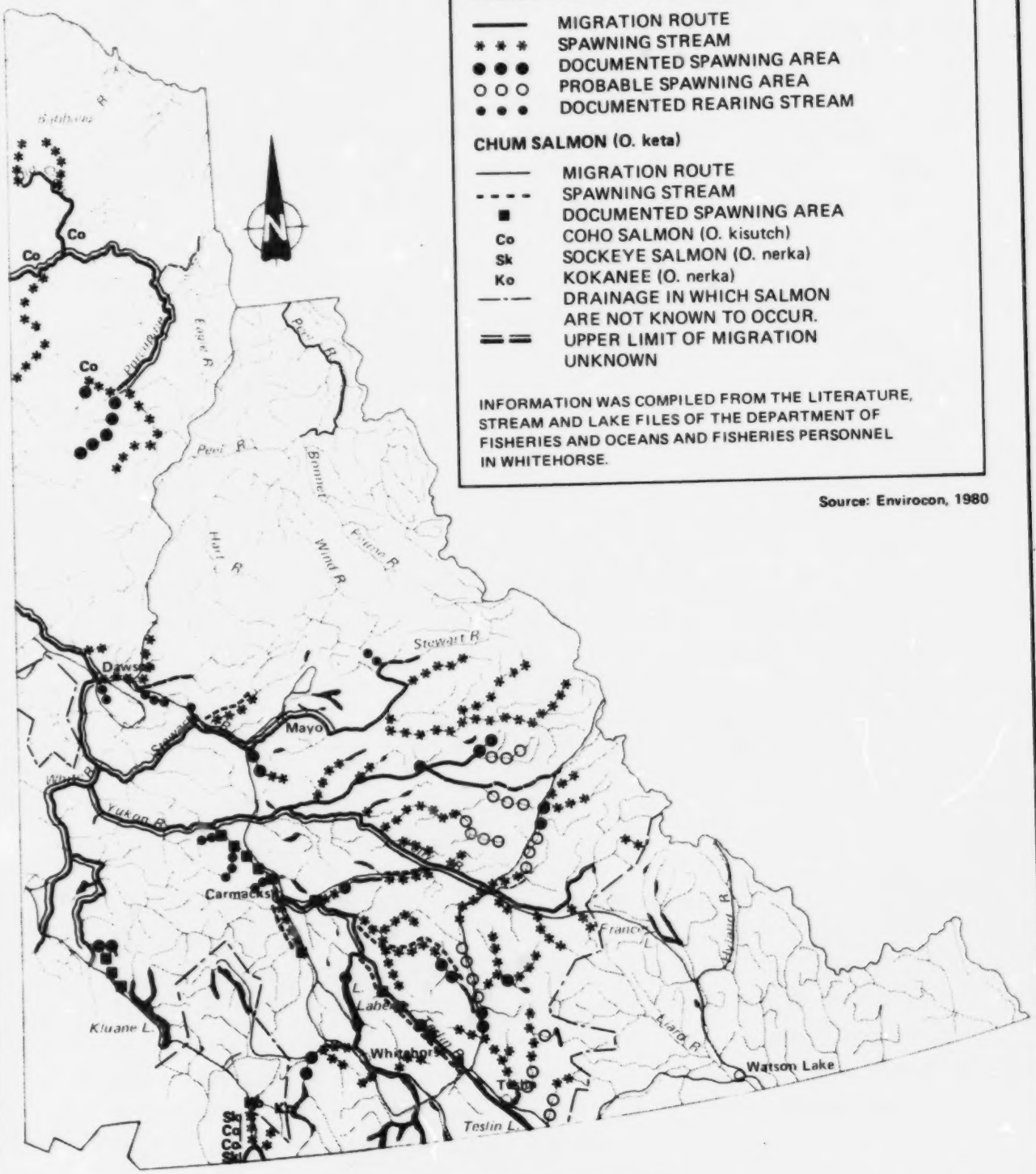
Overall, there are 14 species of fish of importance to commercial, domestic, native and sport fisheries in Yukon. A list of these fish species, included as Table 3.1, includes five anadromous species, with the remainder being freshwater species. Table 3.1 also identifies which of these species is important to each of the four different types of fishing activities occurring in Yukon - commercial fishing, domestic fishing, native fishing and sport fishing. A brief description of the 14 fish species, their distribution and importance is presented in the following sections. Each of the four fisheries is examined in the remainder of this chapter.

a) Anadromous species

Of the five anadromous species of fish found in Yukon, four are different types of Pacific salmon. The most important of the salmon species is the chinook salmon (Oncorhynchus tshawytscha, also called spring or king salmon). Chinook salmon are found in both the Yukon River basin and the Alsek-Tatshenshini System, and are the largest of the salmon species (ranging in size up to 29.5 kg.). A recent survey by Envirocon Limited (1980) identified many of the known chinook spawning and rearing areas; these areas are identified on Figure 3.1. Chi-

Table 3.1 IMPORTANT YUKON FISH SPECIES

	Commercial Fishery	Sport Fishery	Domestic Fishery	Native Fishery
Anadromous species:				
Chinook salmon	*	*	*	*
Chum salmon	*		*	*
Coho salmon		*		*
Sockeye/Kokanee salmon		*		*
Arctic char	*	*		
Freshwater species:				
Lake trout	*	*	*	*
Dolly Varden char		*		
Rainbow trout		*		
Cutthroat trout		*		
Arctic grayling		*		*
Northern pike	*	*	*	*
Whitefish	*	*	*	*
Burbot	*			*
Inconnu	*	*		*



YUKON TERRITORY

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FIGURE 3.1

nook salmon represent a sizeable proportion of the annual commercial catch in Yukon, and are also of considerable importance to the domestic, native and sports fisheries.

Chum salmon (Oncorhynchus keta) are found primarily in the Yukon River drainage area. This salmon species is an important part of the commercial, domestic and native fisheries, with the average size being approximately 3.2 kg. Spawning and rearing areas for chum salmon, plus details of major migration routes are also shown in Figure

Sockeye/Kokanee salmon (Oncorhynchus nerka) are found only in the Alsek-Tatshenshini drainage area. Sockeye are caught as a sports fish in the Dalton Post area, and also provide the basis for an important native fishery at Klukshu. Sockeye range in size from 1.8 to 3.6 kg. at these locations, while Kokanee are somewhat smaller. Kokanee, a land-locked variety of sockeye, are caught as a sport fish at a few locations within Kluane National Park.

Coho salmon (Oncorhynchus kisutch) is the fourth type of Pacific salmon species caught in the Yukon Territory. In a natural state, coho salmon are found in the Alsek-Tatshenshini drainage area where they are caught as a sport fish and in the Porcupine River system where they are caught by native food fishermen. The average size of fish caught ranges between 2.2 and 5.4 kg. Stocking of coho salmon in various lakes in the Yukon River drainage has occurred since 1971 with some degree of success.

The fifth species of anadromous fish found in Yukon is the Arctic char (Salvelinus alpinus). This species of char is found only in streams and rivers along the north coast of Yukon, and grows to an average size of 1 to 1.8 kg. At the present, arctic char is of minor importance to both the sport and commercial fishing industry because of the remoteness of the north slope streams.

YUKON TERRITORY

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FIGURE 3.2

b) Freshwater species

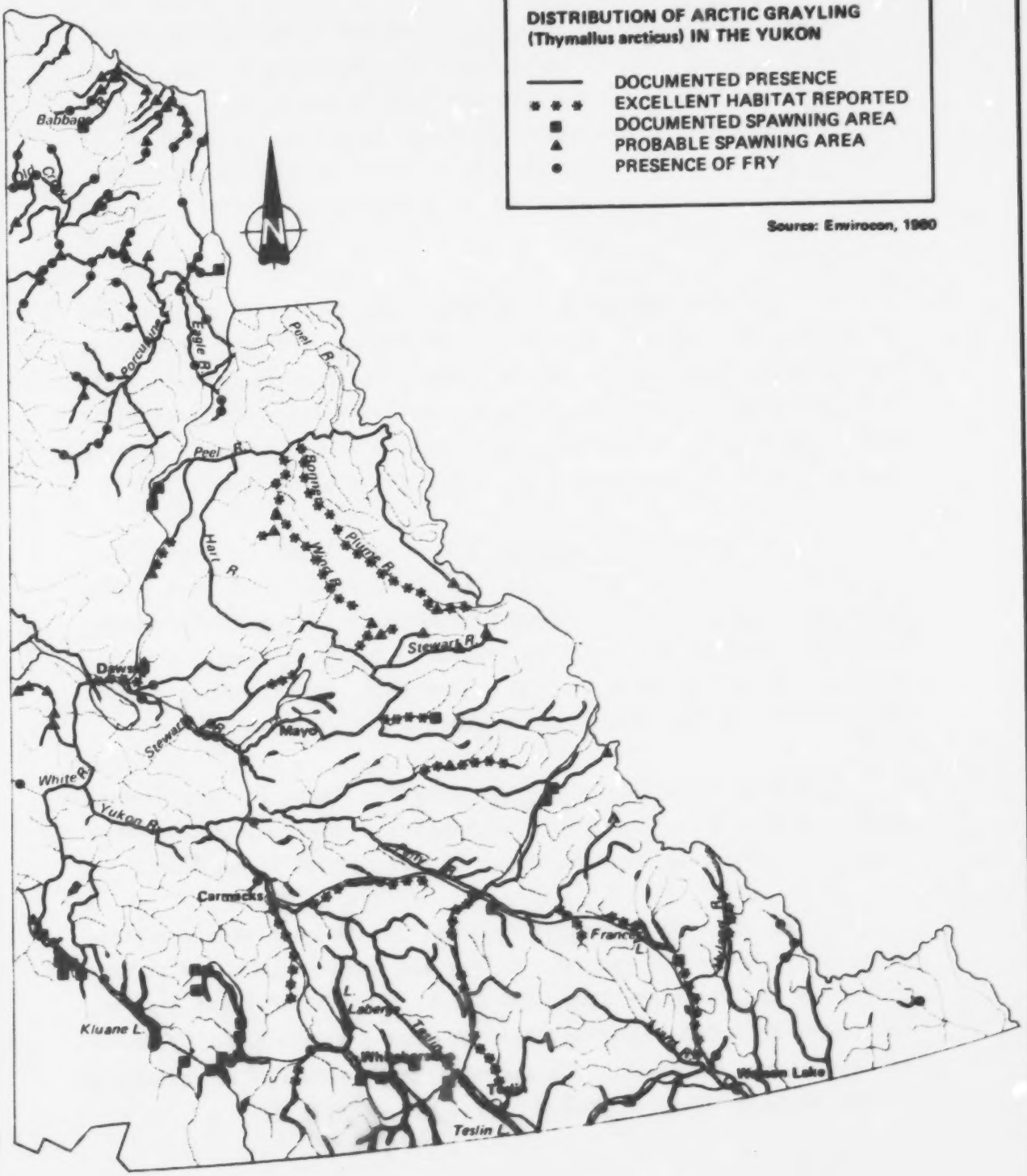
Lake trout (Salvelinus namaycush) are the largest of the freshwater fish species found in Yukon. Some fish weighing in excess of 23 kg. have been caught, but the average size is closer to 2 kg. Lake trout are distributed throughout the Yukon Territory, in lakes of all sizes - see Figure 3.2. This species is preferred by most sport fishermen, but represents an important component of commercial, domestic and native fisheries.

Dolly Varden char (Salvelinus malma) are a close relative of the lake trout, and although they can be anadromous, not much information is available about this species in Yukon. Dolly Varden are found in both the Alsek-Tatshenshini drainage and in the Liard and Peel river basins, inhabiting both lakes and rivers. This species is usually caught by sport fishermen, with the average size being about 0.5 kg.

Rainbow trout (Salmo gairdneri) is a well known sport fish species whose presence in Yukon is due mainly to stocking of lakes. Some small native populations are thought to exist in the Alsek-Tatshenshini drainage. Most rainbow trout are caught by sport fishermen, with the average size being about 0.5 kg. Steelhead, an anadromous rainbow trout, exists in the Tatshenshini system, but only in small numbers.

Cutthroat trout (Salmo clarki) exist in Yukon in very limited numbers only. This species was introduced to the area as part of a stocking program. The current status of this species is not known.

Arctic grayling (Thymallus articus) is the most widely distributed of all Yukon fish species, as they are found in lakes and streams throughout the Territory (see Figure 3.3). The majority of grayling are caught by sports fishermen, although some are net-caught by domestic and native fishermen. Average size grayling weigh approximately 0.5 kg. although they can grow up to 2.3 kg.



YUKON TERRITORY

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FIGURE 3.3

Northern pike (Esox lucius) is also distributed widely throughout Yukon, but in smaller numbers than lake trout or grayling. Pike are popular as a sport fish, sometimes reaching in excess of 10 kg. Northern pike are also caught by commercial and domestic fishermen, and a small local market for pike has developed.

A number of different species of whitefish (Coregonus sp.) can be found in Yukon. Whitefish are distributed throughout the Territory and are fairly heavily utilized by commercial and domestic fishermen. Some sport fishing for whitefish has been reported (Paish, 1981), but is very limited in scope.

Burbot (Lota lota) is a freshwater species of ling cod widely distributed throughout Yukon. As bottom feeders, burbot are usually caught by net fishermen and a small commercial market has developed. This species is also thought to have some potential as a sport fish.

Inconnu (Stenodus leucichthys nelma) is a member of the whitefish family, and is by far the largest, ranging in size up to 20 kg. This species is abundant in the Yukon River system and undergo significant seasonal migrations. Inconnu are usually caught by commercial fishermen although some small ones are caught by sport fishermen.

3.2 The Commercial Fishery

Commercial fishing has occurred in Yukon since the turn of the century, when fish became an important food source for the large influx of gold miners. The fishery declined as the gold rush ended but was revived between 1925 and 1935 in order to provide feed for mink and fox ranches at Carcross and Tagish. Development of the Canol Pipeline and construction of the Alaska Highway once again resulted in a high demand for local fish products, and caused a resurgence in commercial fishing activities.

At the present time two different types of commercial fishing occur. Commercial fishing for chinook and chum salmon occurs during

Table 3.2 SUMMARY OF COMMERCIAL SALMON FISHING ACTIVITIES, YUKON TERRITORY 1972-1982

	Chinook Salmon # Caught	Chum Salmon # Caught
1972	1769	2532
1973	1977	2628
1974	1808	2544
1975	3000	2500
1976	3500	1000
1977	4720	3990
1978	2975	3356
1979	6175	9084
1980	9500	9000
1981	8593	15,260
1982	8640	11,312

Source: Department of Fisheries and Oceans, 1982
Annual Narrative, Yukon Arctic Sub-District

Table 3.3 DISPOSITION OF COMMERCIAL SALMON HARVEST, 1982

	Chinook Salmon Kg.	%	Chum Salmon Kg.	%
Fish Plant Sales	39,827	52.1	17,925	49.9
Other Sales	7,577	9.9	1,086	3.0
Remainder of Catch	28,990	37.9	16,906	47.1
Total Harvest	76,394	100.0	35,917	100.0
Total Pieces	8,640	-	11,312	-

Source: Department of Fisheries and Oceans
Annual Narrative, Yukon Arctic Sub-District, 1982
Torrie Hunter, Dawson Guardian, 1982
Yukon 1982 Salmon Fishery Dawson Area

seasonal fish migrations along the Yukon River near Dawson. A freshwater commercial fishery for lake trout and whitefish operates throughout most of the year on various designated lakes within the Territory. A review of each of these fisheries is presented in the remainder of this section, along with an assessment of the economic benefits generated by the commercial fishery.

a) Anadromous species

Over the last ten years, a major commercial salmon fishery for chinook and chum salmon has developed on the Yukon River near Dawson. Fishermen, using nets or fishwheels, catch chinook salmon during seasonal migrations in July and early August and catch chum salmon in September. At this point, the migrating salmon have travelled nearly 2,100 kilometres up the Yukon River and although flesh quality has deteriorated a little, the catch is still of sufficient quality for smoking, freezing, canning, drying and even fresh sales.

Annual harvests, as shown in Table 3.2, have grown substantially in recent years. This growth can be attributed to a number of different factors, the most important of which are the increased size of the salmon run and the development of markets for salmon products. Based on information from Alaska (Alaska Department of Fish and Game, 1981), both chinook and chum salmon populations were at a peak in 1981, and this is evidenced by the data in Table 3.2. In 1982, however, data from the Alaskan fishery suggested that the chinook run was a little below average and that the chum run was well below average. This information prompted additional closures of the fishery but, even then, the harvests of both chum and chinook in Yukon were above the ten year average.

In the past three years there has been a major change in the markets for chinook and chum salmon from the Dawson fishery. Prior to 1981, fishermen were required to sell their own catches as there were no freezing or canning facilities in the area. Commercially caught fish were either sold dressed fresh or smoked, or were kept for domes-

tic purposes. In 1980, smoked fish were selling for $22 per kilogram for chinook and $17.60 per kilogram for chum. Fresh fish sold for $4.40 per kilogram for dressed chinook and $2.75 per kilogram for chum salmon.

During 1981 the market for commercially caught salmon changed with the opening of the Han fish freezing and packing plant in Dawson. This plant was established and run by members of the Dawson Indian Band, the Old Crow Indian Band and the Council for Yukon Indians. Unfortunately, the plant met with poor success because it was started lated in the season, and had problems with sales and marketing.. In total about 1300 kg. of fish were cleaned, frozen, trucked to Whitehorse and then flown south to Vancouver. Due to problems with the plant, and the abundance of fish in 1981, prices for salmon fell throughout the season from a high of $3.63 - $4.40 per kilogram for chinook (dressed) to only $2.20 per kilogram. With a "glut" of chinook salmon, prices for chum salmon ranged from only $1.10 to $1.65 per kilogram with the consequence that most of the chum were used for dog food.

During the winter of 1981-82, the Han Fishery received financial aid in excess of half a million dollars to expand facilities and install the necessary refrigeration facilities. The plant now has the capacity to process 4,536 kg. of fish per day, and hold 45,360 kg. of fish in storage. For the 1982 season, the plant used two boats to pick up catches from the fishermen, and these catches were returned to the plant for cleaning and processing. Fishermen were offered $1.87 per kilogram for chinook salmon and $0.66 per kilogram for chum salmon. Despite major problems with the pick-up boats, the fishery managed to process 39,826 kg. of chinook and 17,925 kg. of chum during the 1982 season.

A summary of the disposition of the 1982 commercial salmon harvest is presented in Table 3.3. Aside from sales to the Han fishery, Yukon commercial fishermen privately sold about 10 percent of the chinook harvest and 3 percent of the chum harvest. Private sales con-

sisted of dressed fresh fish, smoked strips and smoked sides of fish. The remainder of the harvest (38 percent of the chinook catch and 47 percent of the chum catch) was not reported as being sold, and it is assumed that about half of this catch was kept for domestic use while the other half was sold privately.

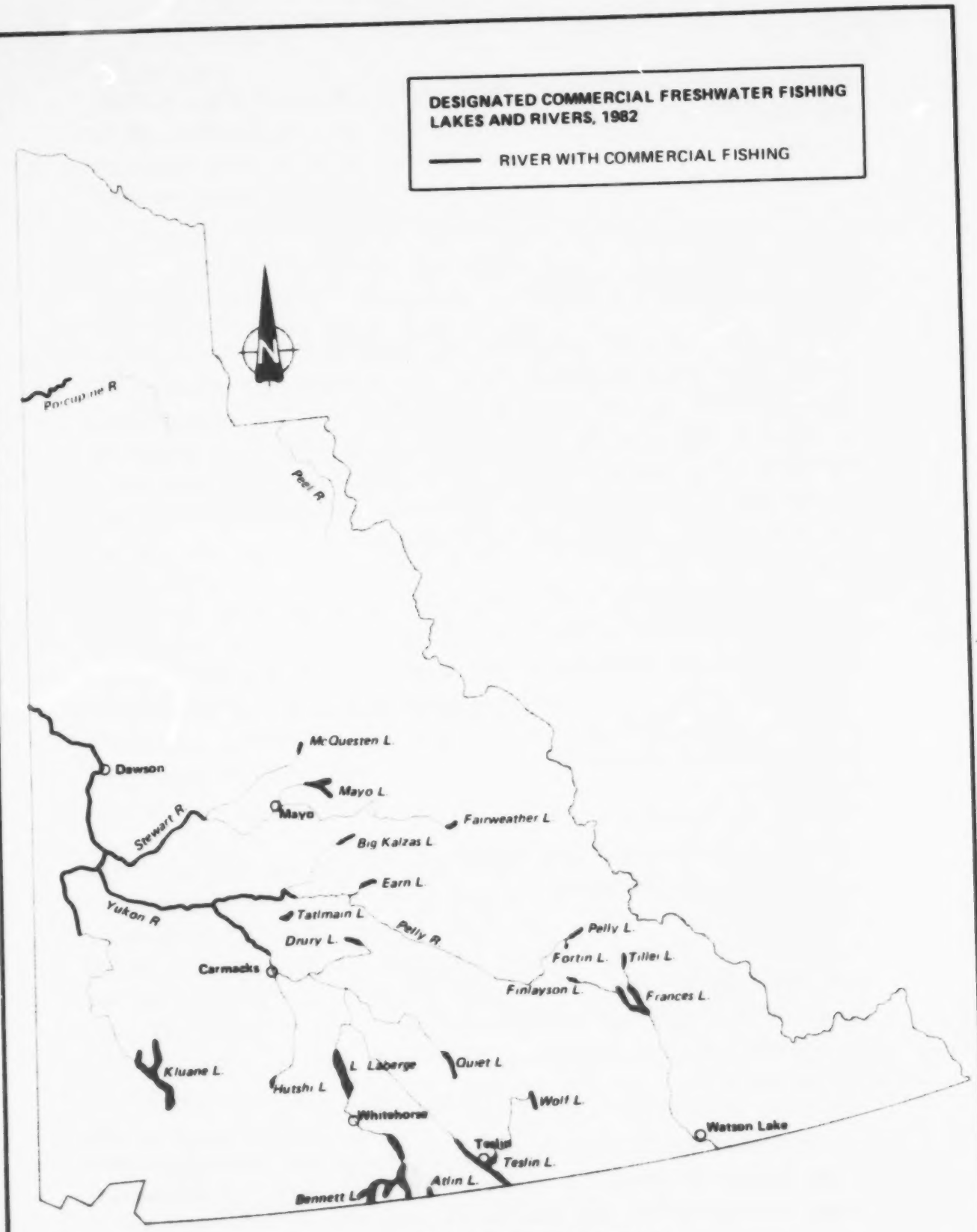
b) Freshwater species

Unlike commercial salmon fishing, commercial fishing for freshwater species occurs throughout Yukon. In 1982 some 20 lakes were open to commercial harvesting, with quotas for lake trout and whitefish harvests. A list of these lakes and the associated quotas are included as Table 3.4, while Figure 3.4 shows the distribution of these lakes within the Territory. In addition, sections of both the Pelly and Yukon rivers were used for commercial net fishing.

The commercial harvest of lake trout and whitefish for each designated lake in 1982 is also shown in Table 3.4. It is immediately apparent from this information that commercial harvests are substantially below quota levels; only 15 percent of the lake trout quota and 12 percent of the aggregate quota were actually harvested. In addition, commercial fishing only occurred at 7 of the 20 designated lakes.

The current quotas were established in 1971 and recorded harvests, as summarized in Table 3.5, have never reached more than 15 percent of the quota. It should be noted, however, that this catch data is not entirely accurate. Harvest statistics are collected from catch cards submitted by commercial fishermen and until recently only some of the catch cards have been returned each year. The reliability of the 1982 harvest data is considered to be very good by comparison to earlier years.

Another indicator of commercial harvesting activities in Yukon is the number of commercial licences sold each year. A different licence is required for each lake and in 1982, some 60 individuals pur-



YUKON TERRITORY

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FIGURE 3.4

Table 3.4 SCHEDULE OF LAKES CURRENTLY OPEN TO COMMERCIAL FISHING AND 1982 HARVEST INFORMATION (in Kg. round weight)

Lake	Aggregate Quota *	Lake Trout Quota	1982 Harvest	
			Whitefish	Lake Trout
Atlin	1,800	900	1,700	867
Bennet	4,000	2,000	1,003	1,282
Big Kalzas	1,800	900	-	-
Drury	1,400	700	-	574
Earn	1,800	900	-	-
Fairweather	1,400	700	-	-
Finlayson	1,400	700	195	30
Fortin	1,400	700	-	-
Frances	5,400	2,700	-	-
Hutshi	1,000	500	-	-
Kluane	17,000	8,500	1,058	795
La Berge	9,000	4,500	1,213	1,290
Mayo	3,600	1,800	-	-
McQuesten	1,800	900	591	-
Pelly	1,400	700	-	-
Quiet	2,800	1,400	-	-
Tatlmain	1,800	900	-	-
Teslin	2,200	1,100	1,934	264
Tillei	1,400	700	-	-
Wolf	3,600	1,800	-	-
TOTAL	66,000	33,000	7,694	5,102

* Lake Trout and Whitefish Combined

Source: Department of Fisheries and Oceans, 1982. Unpublished Memorandum.

Table 3.5 SUMMARY OF COMMERCIAL FRESHWATER FISH HARVESTS ON DESIGNATED LAKES, 1972 - 1982

	Licenses Issued*	Licences Used	Whitefish Harvest (Kg.)	Lake Trout Harvest (Kg.)
1972	55	22	3,894	3,659
1973	79	28	5,585	4,540
1974	66	31	5,358	3,987
1975	64	19	3,050	3,741
1976	42	15	3,268	4,188
1977	48	14	4,398	4,129
1978	50	14	4,268	2,010
1979	56	19	5,994	3,494
1980	65	17	4,489	2,768
1981	86	25	4,345	3,447
1982	111	30	7,694	5,102

* Does not include licences issued for commercial freshwater fishing on Pelly or Yukon rivers.

Source: Department of Fisheries and Oceans
Unpublished memorandum, 1983
Unpublished document, 1983

Table 3.6 SUMMARY OF COMMERCIAL FRESHWATER FISH HARVEST, 1982*

SPECIES	NUMBER OF PIECES	TOTAL WEIGHT (Kg.)	AVERAGE WEIGHT (Kg.)
Lake Trout	2,936	5,102	1.74
Whitefish	6,508	7,803	1.20
Northern Pike	136	344	2.53
Burbot	1,171	1,540	1.32
Suckers	2,070	2,004	0.97
Inconnu	38	63	1.66

* Includes harvests from Pelly and Yukon Rivers

Source: Department of Fisheries and Oceans, 1983
Unpublished memorandum

chased licences to fish on various lakes plus the Pelly and Yukon rivers, resulting in the sales of 115 commercial licences. Of these numbers, only 23 people using 32 different licences actually reported fishing in 1982. This pattern of use is consistent with past sales and use of commercial fishing licences on designated lakes - see Table 3.5.

Although lake trout and whitefish are the most important of the commercial freshwater fish species, four other species of fish are consistently caught. These species include northern pike, burbot, suckers and inconnu. Based on catch card returns, the total harvest of freshwater fish in 1982 is summarized on Table 3.6. This catch represents nearly 17,000 kg. of fish of which lake trout and whitefish accounted for 75 percent.

Details on disposition of the commercial freshwater fish harvest are incomplete and relate only to sales of lake trout and whitefish. Twelve fishermen using 14 licences reported sales of 2,411 kg. of whitefish and 2,207 kg. of lake trout in 1982, but these weights do not include any fish kept for domestic purposes. It is quite possible that domestic use of commercially caught fish could comprise 25 percent of the catch of lake trout and whitefish plus most of the catch of suckers and other species. Sales records for the other 11 fishermen are not available.

Records of lake trout and whitefish sales indicate that most of the commercial catch is consumed in Yukon. Fishermen are able to sell much of their catch to restaurants and food stores, while a small proportion of catch is purchased by institutions in Whitehorse such as the hospital, vocational school, and various government agencies. Fishermen marketing their catch to tourists and other private consumers directly sell a significant proportion of the catch. A breakdown of commercial fish sales in 1982 is presented in Table 3.7.

Table 3.7 COMMERCIAL SALES OF LAKE TROUT AND WHITEFISH, YUKON TERRITORY, 1982

	LAKE TROUT (% of Sales)	WHITEFISH (% of Sales)
Restaurants	53.3	33.1
Grocery Stores	21.0	16.6
Institutions	4.1	5.2
Other (Including private sales)	21.6	45.1

Source: Department of Fisheries and Oceans, 1983
Unpublished document

c) Industry structure

Given the small size of both the anadromous and freshwater harvests, the structure of the Yukon commercial fishing industry is quite simple. Using licence sales information, direct employment in the fish harvesting end of the industry comprised 38 fishermen in the seasonal salmon fishery and 23 freshwater commercial fishermen. These numbers are somewhat misleading, however, because many fishing operations provide employment for family members. Thus, total employment arising from fish harvesting could be as high as 120 to 180 persons. Much of this employment is seasonal (the anadromous fishing only lasts for a period of 3 months) but provides a very important component of annual cash incomes for some people.

The only other form of employment in the commercial fishing industry lies in the fish processing end of the industry. The opening of the Han Fishery in Dawson in 1982 provided seasonal employment for 18 people, many of them members of the Dawson Indian Band. During 1982, the plant was open for a period of 9 weeks, so that total employment would amount to less than 5 man-years. Operation of the plant would have spin-off benefits to the rest of the Dawson and Yukon economies, but the extent of these benefits is not known.

d) Value of the catch

The value of commercial fishing in Yukon can be calculated by combining the harvest data presented earlier with current market prices for commercial fish sales. In making these calculations, all parts of the commercial catch used for domestic purposes have been omitted here but will be included in calculations of the value of the domestic fishery. The values calculated in this section represent the gross income benefits of the fishery. While it is often more appropriate to assess the net benefits of resource use, detailed cost estimates for catching and processing fish in Yukon are not available.

To determine the value of the salmon catch, several different calculations are necessary, depending on how the salmon were sold. Private sales of fish by commercial fishermen in 1982 were based on the following prices per kilogram:

	Chinook salmon	Chum salmon
Fresh, dressed	$ 3.09 - $ 4.62	$2.20 - $3.30
Smoked strips	$26.46	-
Smoked sides	$13.22 - $19.84	$16.50

It was observed during the 1982 season that the amount of smoked fish sold was quite low because it was easier for fishermen to sell their fish to the Han processing plant. On this basis, the weighted average private selling price for chinook salmon was calculated at about $5.96 per kilogram and at $2.64 per kilogram for chum salmon. The total value of private salmon sales is then estimated to have been about $90,160; this estimate assumes that private sales of salmon consisted of "Other Sales" plus 50 percent of the "Remainder of Catch" as reported in the catch disposition information shown in Table 3.3.

About half of the commercial salmon harvest was sold by fishermen to the Han fish plant at $1.87 per kilogram for chinook and $0.66 per kilogram for chum. While these sales resulted in a total income of $86,487 for commercial salmon fishermen, the gross value of the catch depends on the price at which the Han Fishery sells its products to wholesalers and retailers. During the 1982 season, the Han Fishery sold chinook salmon for $5.50 per kilogram and sold chum salmon for $2.87 per kilogram (personal communication, Frank Taylor, manager, Han Fishery). At these prices, sales by the Han Fishery amounted to $270,500. The combined value of the anadromous commercial fishery in Yukon in 1982 is then estimated to have been $360,660.

By comparison, the value of the freshwater commercial catch in 1982 was about $39,500. This estimate is based on the assumption that about 25 percent of the harvest of lake trout and whitefish were kept for domestic purposes, and that the catch of other fish species was

also used for domestic purposes. Sales information collected by the Department of Fisheries and Oceans (unpublished document, 1983) suggests that fishermen received an average price of $4.50 per kilogram for lake trout and $3.80 per kilogram for whitefish in 1982.

Using the estimates for both the anadromous and freshwater commercial fisheries as derived above, the total value of the Yukon commercial fishery in 1982 is estimated to have been $400,160.

e) Future development of the industry

To make some predictions about the future development of the commercial salmon fishery there are two major factors to consider. The most important of these factors is the supply of fish as determined by escapements through the downstream Alaskan fisheries. It would appear from past harvests that Yukon River salmon stocks are being harvested at or near the level required to sustain future fish populations. Expansion of the Yukon fishery would then require more salmon in the Yukon River system, and this could occur either of two ways. First, Alaskan harvests could be curtailed to allow more salmon to move upstream to the Dawson fishery, but this is unlikely considering that Alaskan fishermen are attempting to expand their harvests. This situation may change somewhat with the signing of a Canada - U.S. treaty on salmon fisheries and this is examined further in Section 3.7. The second way to increase Yukon salmon populations is through various enhancement projects that would increase the number of juveniles moving downstream. This solution is not likely to occur given that cost-benefit ratios for Yukon salmon enhancement projects are not favourable and that Alaskan fishermen would be in a position to benefit substantially from the enhanced fish stocks. Thus, the potential for expanding the Yukon commercial salmon fishery is limited by the available fish populations.

Another factor affecting future development of the Yukon salmon fishery is the availability of processing facilities. The Han Fishery provided the incentive for increased salmon catches in 1982, but it is

suggested that more fish could have been processed had salmon runs been larger. At a design capacity of 4,536 kg. of fish per day, the plant could theoretically process twice as much salmon as it did during 1982. One major limitation to reaching this capacity, however, is the difficulty in finding markets for the processed salmon. Yukon salmon are regarded as an "unproven" product by most fish buyers, and the red-skinned salmon produced cannot easily compete with ocean-caught salmon in the fresh frozen market. At the present time, not all of the 1982 catch has yet been sold by the Han Fishery and potential financial problems may result. Consequently, the finding and securing of steady markets for Yukon salmon will determine whether the Han Fishery can remain in operation, let alone reach their design capacity.

The one bright spot in finding new markets for Yukon salmon would be the development of specialty products like smoked salmon, cryovac processed salmon steaks, or even canned salmon. The poorer quality of Yukon salmon would not be as apparent in such products, and effective promotion could help sales as "unique" products from Yukon. The Han Fishery currently has plans to store fish and smoke them during the off-season but the achievement of this objective will be contingent on the continued operation of the Han Fishery.

To predict the value of the commercial salmon fishery in future years, two different scenarios have been developed. The first of these scenarios is based on the continuation of current levels of fishing and processing activities. This scenario is considered most likely based on the assumption that fish stocks would remain at current levels. A second, optimistic scenario assumes that the design capacity of the Han Fishery would be reached and maintained through increases in salmon escapements through Alaska and the securing of markets.

In preparing calculations of the present value of future commercial salmon fisheries benefits, it is assumed that the real value of fish products would increase at a rate of 1 percent per year. This assumption is based on the observation that over the last 11 years the Canadian industry selling price for salmon products has grown at a

slightly faster rate than the overall Industry Selling Price Index, and that the retail price of salmon has grown substantially faster than either the general Consumer Price Index or the Food Price Index (Statistics Canada, 62-010, 62-011).

Like the commercial salmon fishery, the future of the freshwater commercial fishery is limited by the supply of fish, the availability of processing facilities and the securing of markets. Based on current quota levels, the supply of lake trout and whitefish would appear not to place any limitations on future growth of the industry. These quotas are under revision at the present time, however, and it is not yet clear what levels of harvest will be allowed in future years.

It is most likely that growth of the freshwater fisheries will be restricted by the lack of a market of adequate size to justify the construction of processing facilities. A 1980 study for the Council of Yukon Indians (Eby, 1980) concluded that in terms of a high quantity protein fishery, Yukon products could not successfully compete in southern markets due to the lower prices of similar products sold by the Freshwater Fish Marketing Corporation. Thus, it was concluded that a freshwater fish processing plant should not be built. Unfortunately, the study does not consider the potential for developing specialty Yukon products like canned or smoked lake trout or whitefish. Many Yukoners feel that the specialty market shows considerable development potential and requires further study.

Again, the value of future freshwater commercial fishing is considered using two scenarios. A status quo scenario is adopted as the most likely future of the industry. It is assumed that current levels of harvest would remain steady, with all production being sold locally. An optimistic scenario is also considered. This scenario assumes that a processing plant is built to produce specialty items and that the requirements of such a plant would be 900 kg. of fish per day or about 27,000 kg. for a 30 day seasonal operating period. These estimates are consistent with the Eby analysis, and represent a level of harvest equal to 2.5 times the existing level of catch. In determining the

present value of fisheries benefits under each scenario, the value of fish products is assumed to increase in real terms at a rate of 1 percent per year; this assumption is consistent with historic trends.

The present value of future commercial fisheries harvests are calculated below using the two scenarios described above and various discount rates.

Present Value of Commercial Fisheries
(million 1983 $)

Scenario	Discount Rate		
	5%	10%	15%
Status Quo	10.20	4.89	3.28
Optimistic	20.90	10.02	6.74

(Note: These present value calculations plus all others showing the value of Yukon fisheries resources consider future benefits over an infinite time period.)

In terms of employment benefits, the commercial fishery is expected to continue to provide seasonal jobs for 60 licensed fishermen, 60 to 120 assistant fisherman plus 18 people involved in fish processing, under the status quo scenario. If the commercial fishery develops according to the optimistic scenario, twice as many fishermen would participate in the salmon fishery, while the number of freshwater commercial fishermen might increase by a factor 2.5. Another 3 jobs in fish processing would arise from the development of a freshwater fish processing plant. Overall, employment in the commercial fishery would amount to 140 to 200 seasonal jobs for the status quo scenario and between 280 and 410 jobs for the optimistic scenario.

3.3 The Domestic Fishery

Like the commercial fishery, the domestic fishery is split between anadromous and freshwater fish species. Domestic fishing is

defined as the harvesting of fish specifically for personal consumption and applies to non-native households; domestic fishing by natives is considered in section 3.4. A review of domestic fishing in Yukon is presented below.

a) Anadromous species

All domestic fishing for anadromous fish occurs along the Yukon River downstream from Tatchun Creek, and in parts of major tributaries like the Pelly, Stewart and White rivers. In 1982 a total of 24 domestic licences were issued to salmon fishermen. Of this total, only 21 licenced fishermen actively fished. Average catch per fisherman was 21 chinook salmon and 32 chum salmon. These catches are lower than in previous years, and reflect the poorer salmon runs since the peak years in 1980-81. A summary of domestic salmon catches over the last 9 years is presented in Table 3.8; this catch is in addition to salmon caught by commercial fishermen and kept for domestic purposes as described in Section 3.2. It should be noted that the data described in the table are based on catch cards completed by licenced fishermen, and that harvest data in recent years (since 1981) is considerably more accurate in previous years.

b) Freshwater species

Separate licencing of domestic fishermen first occurred in 1973. Domestic fishing activities are not limited to quota lakes (see Table 3.4), and in recent years domestic fishermen have been allowed to fish in many non-quota lakes throughout the Territory. This arrangement is felt to be very beneficial to many trappers and other individuals who are often far removed from year-round food sources. In 1982 a total of 115 licences were issued for fishing on quota lakes and another 30 licences were issued for non-quota lakes and rivers. The geographical locations of these lakes and rivers is illustrated in Figure 3.5.

Domestic freshwater fishing activities tend to focus on lake trout and whitefish species, although a variety of other species

YUKON TERRITORY

SCALE 1:5,000,000

FIGURE 3.5

Table 3.8 DOMESTIC SALMON HARVEST, 1974-1982

	Chinook Salmon		Chum Salmon	
	# of Pieces	Weight (Kg.)	# of Pieces	Weight (Kg.)
1974	406	3,683	466	1,480
1975	400	3,629	2,500	7,938
1976	500	4,536	500	1,588
1977	531	4,817	1,499	4,760
1978	421	3,819	728	2,312
1979	1,200	10,886	2,000	6,350
1980	3,500	31,750	4,000	12,700
1981	715	6,486	1,719	5,458
1982	435	3,946	683	2,169

Source: Department of Fisheries and Oceans, Annual Narrative, Yukon Arctic Sub-District, 1978-1982

Table 3.9 SUMMARY OF DOMESTIC FRESHWATER FISH HARVESTS ON DESIGNATED LAKES, 1974-1982*

	Licences Issued	Licences Used	Whitefish Harvest (Kg.)	Lake Trout Harvest (Kg.)
1974	38	9	550	156
1975	32	13	1,192	232
1976	38	9	1,500	175
1977	42	11	1,569	412
1978	68	20	1,010	962
1979	61	9	325	178
1980	67	9	184	58
1981	119	22	1,136	469
1982	115	25	1,462	427

* Domestic Licences were not issued prior to 1974

Source: Department of Fisheries and Oceans
Unpublished memorandum, 1983
Unpublished material

Table 3.10 SUMMARY OF DOMESTIC FRESHWATER FISH HARVEST, 1982

SPECIES	Number of Pieces	Total Weight (Kg.)	Average Weight (Kg.)
Lake Trout	302	476	1.58
Whitefish	1,885	1,876	1.00
Northern Pike	165	269	1.63
Burbot	186	164	0.88
Suckers	1,164	787	0.68
Inconnu	21	34	1.62

Source: Department of Fisheries and Oceans, 1983
Unpublished Memorandum

Table 3.11 VALUE OF DOMESTIC HARVEST, 1982*

	Personal Consumption		Dog Food	
	Amount (Kg.)	Value	Amount (Kg.)	Value
Chinook Salmon	16,597	$127,797	1,844	$ 2,305
Chum Salmon	1,062	8,177	9,560	11,950
Lake Trout	1,751	8,755	0	0
Whitefish	1,913	5,854	1,913	2,391
Northern Pike	613	2,452	0	0
Burbot	1,704	6,816	0	0
Suckers	0	0	2,791	3,489
Inconnu	47	144	48	60
TOTAL	23,687	$159,995	16,156	$20,195

* Includes fish caught by commercial fisherman but used for domestic consumption.

including northern pike, burbot, suckers and inconnu are also caught. Historically, the catch of lake trout and whitefish on quota lakes has not been very large - see Table 3.9 - but this may partly be caused by inaccuracies in the reporting procedures utilized prior to 1981. However, the domestic catch represents less than 15 percent of the commercial catch over the same period. The number of domestic fishing licences on quota lakes has grown steadily since 1974, but the number of active fishermen has remained relatively consistent. It is interesting to note that harvests of freswater species are lowest in those years when harvests of salmon species are quite high.

The total harvest of all freshwater species by domestic fishermen in 1982 amounted to 3,606 kg. Over half of this catch was whitefish, with suckers and lake trout being next in importance. A complete summary of the domestic harvest on all lakes and rivers in 1982 is presented as Table 3.10. These estimates do not include the component of the commercial catch used for domestic purposes; estimated about 7,177 kg., comprised mainly of suckers and whitefish.

c) Industry structure

While the domestic fishery does not really represent an industry in the usual sense, it does provide part time employment for those people who fish. The benefits of this employment are gained in terms of the foodstuffs produced.

Domestic fishing for salmon involved 21 licenced fishermen while 38 licenced fishermen actively participated in the freshwater fishery. Typically, however, many fishermen use family members to help in the tending of nets, and the cleaning, drying and storing of fish. As a result, it is estimated that between 120 and 180 people actually participate in the domestic fishery on a part time basis each year.

d) Value of the catch

It is not possible to directly measure the value of the domestic fish harvest. Fishermen do not receive any monetary benefits from the catch but do experience benefits from not having to purchase an equivalent amount of fish for personal consumption or for use as dog food.

Thus, the valuation procedure used here attempts to determine how much the fisherman saved by catching fish rather than by buying it.

The domestic catch can be broken up into two different end uses, and each use has its own measure of value. Fish used for dog food is valued in terms of what people would have to pay for alternate forms of dog food, assuming that fish were no longer available for this use. Currently in Whitehorse, 20 kg. bags of dry dog food cost about $25, or about $1.25 per kilogram. Assuming that 1 kg. of fish is equivalent in nourishment to 1 kg. of dry dog food, fish used for dog food is valued at $1.25 per kilogram. The amount of fish used for dog food is not known in exact detail, but it is estimated that 90 percent of chum salmon, 10 percent of chinook salmon, 50 percent of whitefish and inconnu, plus 100 percent of suckers are probably used to feed dogs. This represents about 16,156 kg. of fish, worth approximately $20,195 (see Table 3.11).

The rest of the domestic harvest was used for personal consumption. Most domestic fishermen plus some commercial fishermen live in relatively isolated areas, so that fish represent an easily available food source. The value of fish caught and used for personal consumption is based on the amount that people would have to spend to purchase an equivalent amount of fish from a retail outlet. A survey of fish prices in Yukon supermarkets suggest the following retail prices would apply:

Salmon	$7.70 /kg.
Lake Trout	$5.00 /kg.
Whitefish	$3.06 /kg.

Using these prices, the value of fish consumed by commercial and domestic fishermen in 1982 amounted to about $159,995, as per Table 3.11.

Based on the calculation above, the total value of the Yukon domestic fishery in 1982 amounted to $180,190. It should be noted that while this amount represents the gross value of the fish consumed by commercial and domestic fishermen, these benefits are enjoyed outside the market place. Consequently, the benefits derived from the domestic fishery are not included in any aggregate measure of economic activity within Yukon.

e) Future development of the fishery

Two major factors will determine the future development of the domestic fishery. The most important influence is the supply of fish. In the domestic salmon fishery, harvests are directly proportional to the size of the salmon runs. If salmon runs were to be increased, domestic harvests would likely increase. However, the likelihood of a major increase is unlikely given the existence of the downstream Alaskan fishery and the high cost of salmon enhancement programs in Yukon.

For the freshwater domestic fishery, current fish populations do not appear to be a limiting factor because combined commercial and domestic harvests are still well below quota levels, and many lakes remain to be fished. However, quota levels are under review and it is possible that they may be reduced for some lakes. Unless these reductions are very severe, it is doubtful that domestic harvests will be affected given the relatively low catches occurring at present.

The second major consideration affecting the future of the domestic fishery is the demand for fish for domestic purposes. Demand for fish is linked to many different factors, including the prices of commercial dog food, fur prices (affects the number of active trappers and their incomes), the prices of alternate foodstuffs, regional population growth, unemployment, fish prices offered for commercial

sales, etc. Given this complicated relationship, it is difficult to predict how the demand for domestic fish may change. Based on trends in recent years, however, it would appear that dramatic changes in demand are not very likely.

Predictions of future fisheries values are based on two different scenarios. As in the commercial fishery, the most likely scenario is for maintaining the staus quo situation for both salmon and freshwater species. It is not likely that salmon runs will increase in size, nor is it likely that the demand for freshwater species will change considerably. As a second and optimistic scenario, it is assumed that salmon runs would double in size; this is compatible with the optimistic scenario developed for the commercial fishery. On this assumption, domestic catches of salmon would also double. For the freshwater fishery only one scenario is considered. This scenario assumes no change in current harvest levels for the reasons that a significant change in demand is not likely and that quota restrictions on designated lakes would limit domestic fisheries, if the commercial freshwater harvest was allowed to increase according to the optimistic scenario for commercial fishing detailed in section 3.2. In making the present value calculations, the real price of fish products is assumed to rise at 1 percent per year on the basis of observed historical changes in consumer and wholesale fish prices vis-a-vis changes in the general consumer and industrial price indexes.

Based on the scenarios above, the present value of the Yukon domestic fishery has been calculated using a variety of discount rates, as shown below:

Present Value of Domestic Fishery
(million 1983 $)

Scenario	Discount Rates		
	5%	10%	15%
Status Quo	4.59	2.20	1.48
Optimistic	9.18	4.40	2.96

Based on current levels of participation, future development of the domestic fishery according to the status quo scenario would result in some 60 licensed fishermen plus 60 to 120 assistants actively fishing on a part-time basis each year. Doubling of salmon runs, as assumed in the optimistic development scenario for domestic fishing, would attract another 20 licensed fishermen and 20 to 40 assistants.

3.4 The Native Fishery

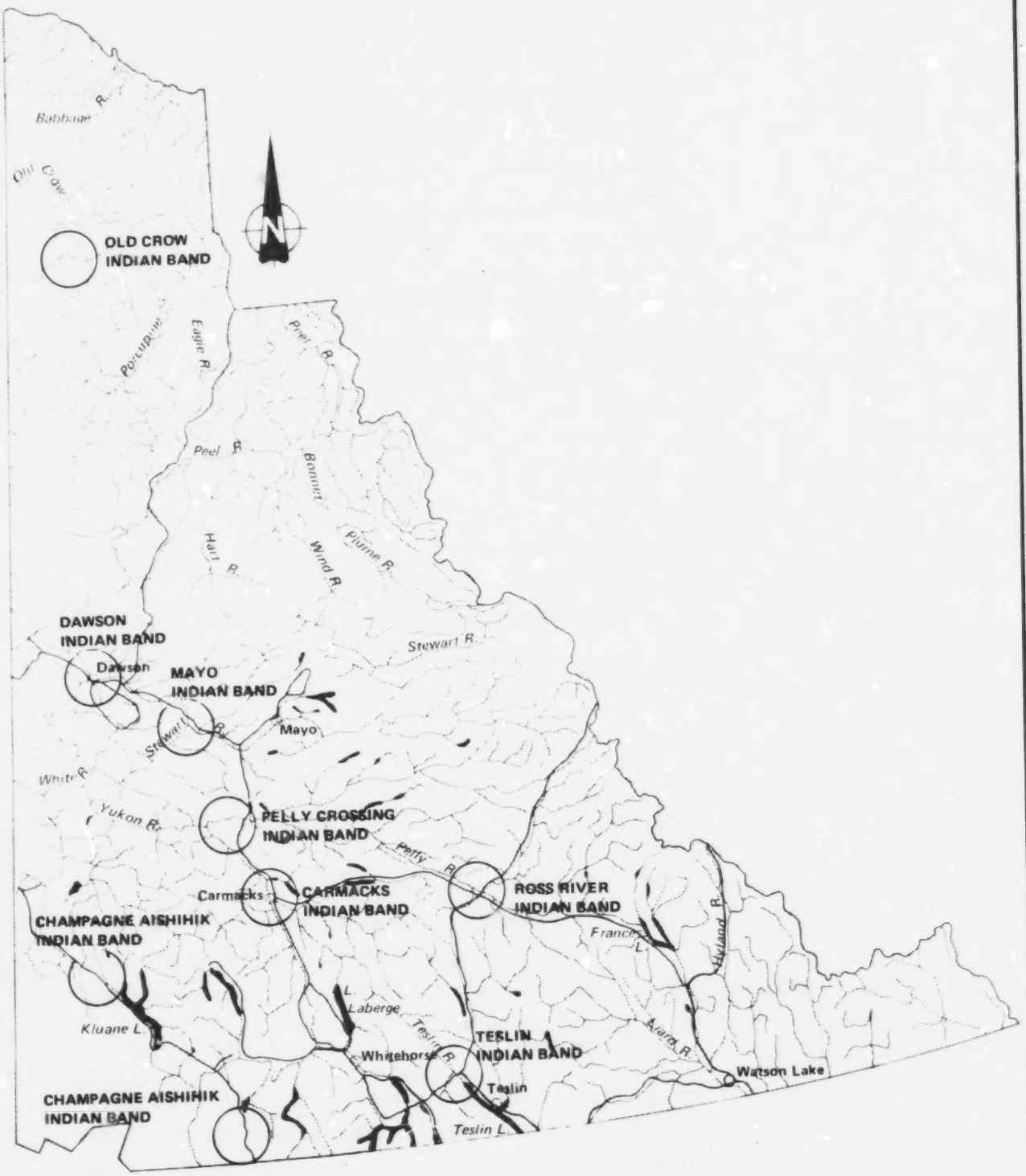
Indian people in Yukon have always harvested fish for domestic purposes. Although wage employment and alternate sources of food are now available, many Indian people still rely on fish for much of their food supply. Both salmon and freshwater species are harvested each year, often in areas that have been used by Indian people for centuries. Fish are usually caught by net, and then dried for future use. Harvesting is often a co-operative effort, involving numerous families and family members, with much of the catch going to band elders. For many Indian people, subsistence fishing still represents an important cultural and traditional element of their lifestyle.

a) Anadromous species

Eight Indian bands scattered throughout Yukon participate in the subsistence salmon fishery. Fishing activities usually occur fairly close to population centres (see Figure 3.6) with fish camps spread out along the Yukon River and its numerous major tributaries, and in the Alsek-Tatshenshini area. Recent harvest statistics (see Table 3.12) indicate that the annual subsistence catch varies between 15,000 and 20,000 salmon. The catch consists of four different species - chinook, chum, sockeye and coho - with the importance of each species depending on annual variations in the different salmon runs.

Of the four salmon species, chinook salmon is the most important. Chinook are the most widely distributed of the salmon species, and their size and eating quality make them the preferred catch. Chum

IMPORTANT AREAS FOR NATIVE SALMON FISHING



YUKON TERRITORY

SCALE 1:5,000,000

FIGURE 3.6

salmon are less widely distributed and are often caught for use as dog food. Coho salmon are harvested only by the Old Crow band, and have recently declined in importance due to the availability of other food sources (caribou). The sockeye harvest is restricted to the Tatshenshini-Alsek river system where members of the Champagne-Aishihik Band have built fish traps near Klukshu, and use gaffs to catch the individual fish. For species other than chum salmon, the majority of the catch is saved for personal consumption; 70 percent is dried, 10 percent is frozen, and the remaining 20 percent is eaten fresh.

In regulating the native subsistence fishery, a permit system was introduced in the mid 1970's. This system is slow to be accepted, and consequently, harvest data is not entirely reliable. To help record catches, a reporting system based on catch calendars was introduced in 1981 with good success. This catch data is supplemented with visits to fish camps and counts of drying fish, with a door-to-door follow-up during the winter months.

Details of the native salmon harvest in 1982 are presented in Table 3.13. A total of 218 permits were issued, and total harvest was in excess of 17,300 fish, with chinook comprising the majority of the catch. Based on this data it would appear that the Champagne-Aishihik Band, the Pelly Crossing Band and the Mayo Band rely most heavily on subsistence salmon harvests.

b) Freshwater species

Subsistence fishing for freshwater species occurs throughout the Yukon Territory. This part of the subsistence fishery is not regulated in any way however, so that there are no reliable records of catch or number of fishermen. Some isolated records indicate that harvests of freshwater fish are usually between 1.5 and 3 times the number of salmon caught in any given year. On this basis, the freshwater fish harvest by Indian people could amount to between 26,000 and 50,000 fish. Harvests are typically comprised of whitefish, lake trout, pike,

Table 3.12 NATIVE SALMON FISHERY, 1978-1982*

	CHINOOK # PIECES	CHUM # PIECES	SOCKEYE # PIECES	COHO # PIECES	TOTAL # PIECES
1978	3,350	11,000*	8,000	*	22,350
1979	3,785*	5,982	7,000	*	16,767
1980	10,700*	3,500	*	1,500	15,700
1981	9,079	5,340	2,000	500	16,919
1982	8,233	4,096	5,400	*	17,729

Table 3.13 NATIVE SALMON HARVEST, BY INDIAN BAND, 1982

NAME OF BAND	NUMBER OF PERMITS	CHINOOK SALMON	CHUM SALMON	SOCKEYE SALMON	COHO SALMON
Dawson	5	50	20	-	-
Champagne-Aishihik	70	400	400	5,000	-
Carmacks	26	3,172	676	-	-
Mayo	15	720	-	-	-
Pelly Crossing	42	2,940	2,000	-	-
Ross River	22	51	-	-	-
Teslin	38	500	-	-	-
Old Crow	-	400	1,000	*	*
Total	218	8,233	4,096	5,000	*

* Data incomplete

Source: Department of Fisheries and Oceans,
Annual Narrative, Yukon Arctic Sub-District, 1982.
Annual Narrative, Alsek-Taku Sub-District, 1982.
Annual Narrative, Northern B.C. - Yukon South Sub-District, 1982.

suckers and burbot with most of the whitefish and suckers being used for dog food.

c) Economic importance

Tne native subsistence fishery represents an important source of food, for both dogs and people, and the value of the food produced represents an important economic benefit of the fishery. As described in Section 3.3 above, the method used for evaluating these benefits is based on replacement cost: the cost of purchasing an equivalent amount of food from a retail outlet. For salmon, the value of fish used for dog food was determined to be about $1.25 per kilogram, while the retail value of Yukon salmon is supermarkets was found to be about $7.70 per kilogram. Using the information in Table 3.13, the native fishery produced about 11,705 kg. of chum salmon for dog food, with about 87,330 kg. of fish being consumed by Indian people. On this basis the Yukon native subsistence salmon fishery is estimated to have produced $687,070 worth of food products. The value of freshwater fish harvested by native fishermen has not been calculated due to lack of knowledge about the size and composition of the catch.

d) Social importance

The second measure of the importance of subsistence fishing is the cultural and heritage values that Indian people enjoy. Cultural values are quite significant for many Indian people, and often represent the reasons why native people would prefer to continue traditional subsistence harvesting activities rather than participate in a wage economy. No acceptable method for measuring these values has ever been developed; consequently, no measure of the cultural values associated with the Yukon subsistence fishery is included here. It should be noted, however, that the Department of Fisheries and Oceans recognizes the importance of these cultural values in that Indian people are given the first priority in fisheries management decisions.

e) Future development of the native fishery

The future development of the native fishery in Yukon depends on a wide variety of factors, including the size of the native populations, employment opportunities in a wage economy, retail food prices, and a host of other factors including cultural values. One other factor of major significance to continuation of the native fishery is the availability of salmon. In recent years the native fishery has become more and more restricted as fisheries managers attempt to compensate for heavy harvesting activities in downstream locations. This problem is particularly difficult in Yukon, where many of the downstream fisheries are outside of federal jurisdiction and beyond Canadian control. However, it is the mandate of the Department of Fisheries and Oceans to ensure that Yukon Indian people do receive an adequate supply of fish, even if it means cutting back on the commercial, domestic, and sport catches. On this basis, Yukon Indians can be assured a future supply of salmon, even though this supply may vary from year to year.

Based on an agreement in principle signed last year by the Council for Yukon Indians and the federal govenment, the character of Indian fishing may change sustantially in future years. The agreement calls for the establishment and protection of certain fishing rights for Yukon Indians, an allocation of fish between Indians and other Yukoners, and Indian participation in the commercial fisheries. In addition, Indian people would be represented in fisheries management decisions.

In predicting the future value of the native fishery two consistent with the development scenarios for commercial and domestic fisheries. The status quo scenario assumes that Indian harvests of salmon would remain at current levels. It is assumed that even with a new agreement on Indian fisheries, the level of harvest will probably not be substantially higher than current levels. The optimistic scenario assumes that salmon escapements to Yukon double, either through international agreement or salmonid enhancement. With twice as many fish

available, it is assumed that twice as many Indian people would participate in the fishery and that the harvest would double in size.

As with the commercial and domestic fisheries, it is assumed that the value of the fish products caught by native fishermen will increase in real terms in the future. The rate of increase in real value is assumed to be 1 percent per year. This assumption, in combination with the terms of the scenarios described above, has been used to determine present value of future native salmon harvests:

Present Value of the Native Fisheries
(million 1983 $)

Scenario	Discount Rate		
	5%	10%	15%
Status Quo	17.51	8.39	5.64
Optimistic	35.02	16.79	11.29

For the status quo scenario for the native salmon fishery it is assumed that the number of fishing permits issued to Indian people would remain about the same as in 1982. While the number of permits issued may not be an accurate reflection of total participation in the native fishery, this represents the only source of information available. For the optimistic scenario, it is assumed that doubling of salmon stocks would attract twice as many Indian fishermen. Thus, some 436 fishermen would be active in the native fishery under the optimistic development scenario, compared to 218 native fishermen under the status quo scenario.

3.5 The Sport Fishery

For both residents and non-residents alike, the Yukon Territory provides a diversity of sport fishing opportunities. Anglers can fish

Table 3.14 SALES OF SPORTS FISHING LICENCES, 1972 - 1981

	RESIDENT	NON RESIDENT			TOTAL
		Short Term	Long Term	Total	
1972/73	5,104	3,719	785	4,504	9,608
1973/74	6,629	4,232	1,039	5,271	11,900
1974/75	7,783	3,245	835	4,080	11,863
1975/76	8,578	3,549	1,088	4,637	13,215
1976/77	8,881	3,222	869	4,091	12,972
1977/78	9,642	3,865	1,105	4,970	14,612
1978/79	10,401	3,969	1,351	5,320	15,721
1979/80	10,987	3,503	2,343	5,846	16,833
1980/81	11,892	3,460	1,911	5,371	17,263
1981/82	11,867	3,574	1,910	5,484	17,351

Source: Department of Renewable Resources
Yukon Territorial Government

Table 3.15 DISTRIBUTION OF SPORT FISHING ACTIVITIES, 1980
(Angler-days)

ZONE	YUKON RESIDENTS	NON-RESIDENTS	TOTAL	DISTRIBUTION BY ZONE
Southwest	10,215	10,680	20,895	13.6%
Tatshenshini	8,740	3,670	12,410	8.1%
South Central	31,640	11,470	43,110	28.0%
Southeast	12,520	9,485	22,005	14.3%
Central	26,620	7,170	33,790	22.0%
North Central	10,655	4,125	14,780	9.6%
Northern	3,410	3,400	6,810	4.4%
TOTAL	103,800	50,000	153,800	100.0%

Source: Department of Fisheries and Oceans,
Unpublished 1980 survey data

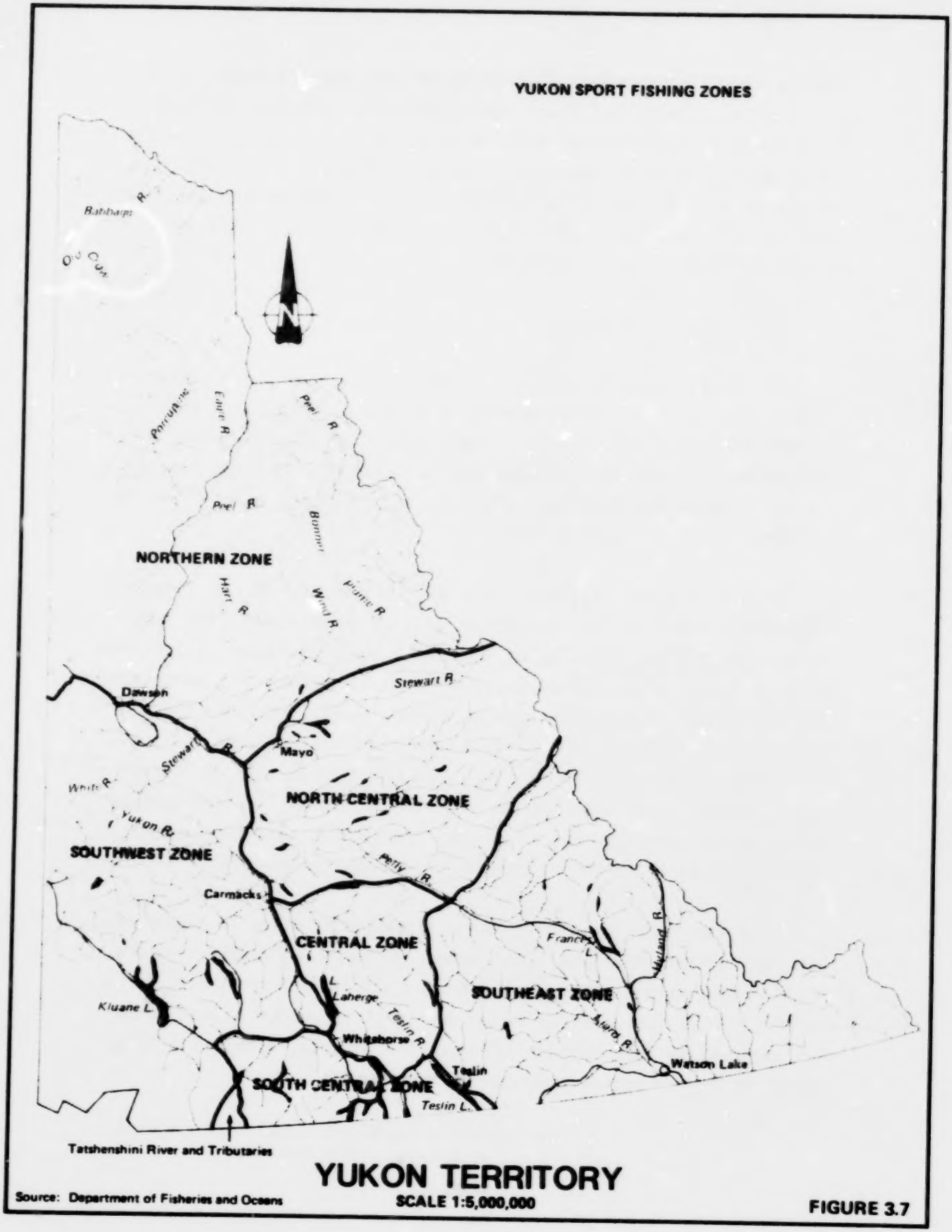
for lake trout and northern pike in any of the lakes in Yukon, or they can fish the streams and rivers for grayling and salmon. The quality of fishing is considered by many residents to be one of the definite advantages of a major reason for living in Yukon. Similarily, the reputation of the Yukon sport fishery serves to attract tourists from the rest of Canada and other parts of the world. A description of this sport fishery is presented below.

a) Number of anglers

As shown in Table 3.14 the number of licenced sport fishermen in Yukon has been increasing steadily over the last decade. The major reasons for these increases have been regional population growth plus the steady expansion of the Yukon tourist industry. Overall, the number of licenced fishermen has increased at an average annual rate of 6.8 percent over a 9 year period.

Yukon residents represent the greatest proportion of licenced fishermen. Based on the results of two survey programs, the number Yukon sport fishermen increased from 6,032 in 1975 to 7,246 in 1980 This represents an average increase of about 3.7 percent per year, just slightly higher than the average population growth rate over the same period. Other surveys confirm this high participation rate for Yukon residents; a study by Burton in 1977 found that 33 percent of Yukoners fish once every two weeks during the fishing season, 22 percent fish once a month, while another 14 percent fished less than once a month. Only 29 percent of Yukoners reported not having fished in 1977.

The greatest increase in sport fishing activities in Yukon has been by Canadian tourists. The number of licenced Canadian anglers, based on 1975 survey data, reached about 4,625 in 1980 from about 2,704 in 1975. This represents an annual growth of 11 percent. Most Canadian anglers are from British Columbia and Alberta, although a large number of Ontario residents fished in Yukon in 1980.



YUKON TERRITORY

Source: Department of Fisheries and Oceans

SCALE 1:5,000,000

FIGURE 3.7

The number of licenced anglers from outside Canada has also increased but to a lesser extent. Licence sales show an average annual increase of 6 percent, jumping from 3,928 licences in 1975 to 5,204 1980.

b) Angler effort

Total angler effort in 1980 is estimated to have been about 154,000 angler days (see Table 3.15). Of this total, Yukoners spent about 104,000 days fishing, or about 17.8 days per active angler. This level of effort is just slightly below the 18.6 days per year reported in 1975. Visitors from outside Yukon spent considerably less time fishing - only 50,000 days in 1980. Active anglers fished for an average of 6.2 days during their trips to Yukon, which lasted about 16.2 days. Angling effort by tourists averaged only 5.8 days per year in 1975, suggesting that fishing is an increasingly important attraction of the Territory.

Within the Territory, most angling activities occur within the South Central Zone. This zone - see Figure 3.7 - has a high resident population and is easily accessible to tourist traffic. The adjacent Central Zone is also heavily fished, probably for the same reasons. Perhaps the most intensively fished of all zones in Yukon is the Tatshenshini River and its tributaries. Despite its small size, approximately 12,410 days of angling activity were recorded in this zone in 1980; this represents more than 8 percent of total angling in Yukon. A complete breakdown of angling activities by zone is presented in Table 3.15.

c) Sport fish catch

Although all the results of the 1980 survey of anglers in Yukon have not yet been fully tabulated, it is possible to describe the composition of the sport fish catch. For both Yukon residents and non - residents, Arctic grayling comprised the greatest part of the catch -over 50 percent. Lake trout and northern pike were next in impor-

tance, representing 20 percent and 15 percent of the catch, respectively. By comparison, other fish species were only a small component of the catch. Salmon species, including chinook, coho and sockeye, constituted about 5 percent of the reported catch. The remainder of the sport catch was mainly rainbow trout, although small numbers of whitefish, Arctic char, inconnu and Dolly Varden were also reported The total number of fish caught and the weight of the 1980 catch is not yet known.

d) Value of the sport fishery

There are three different measures of economic benefit arising from sport fishing activities. A first measure is an estimate of the consumer surplus benefits enjoyed by resident fishermen. Consumer surplus is a measure of the value of the fishing experience, over and above the cost of participating in the fishery (licence costs), and represents a measure of the feeling of well-being that anglers get from fishing. No studies of Yukon anglers to measure the consumer surplus benefits arising from sport fishing have ever been attempted, but a number of similar studies have been done in British Columbia and other locations along the Pacific Coast. For purposes of this evaluation, a figure of $15 per day has been used as a measure of consumer surplus. This estimate is based on the results from two different studies. For freshwater salmon fishing, a study by Masse and Peterson (1977) concluded that the value of chinook salmon fishing was about $25 per day. This value was based on a review of several fisheries evaluation studies undertaken in British Columbia, Washington and Oregon. In the study, consumer surplus values were determined by asking anglers what amount of money they would be prepared to pay to continue fishing in a given location. For other types of freshwater fishing, a study by Quadra Economic Consultants Ltd. used an estimate of about $10 per angler day in 1977. This value estimate was based on an earlier survey of British Columbia anglers. Using these two estimates, and considering the mix of sport fishing activities in Yukon, an overall estimate of $15 per angler day was derived. On this basis, Yukon residents enjoyed about $1.56 million worth of consumer surplus benefits in 1980.

Similarly, consumer surplus benefits for Canadian anglers fishing in Yukon amounted to about $0.35 million.

For 1982 consumer surplus benefits are estimated at $1.48 million for Yukon residents and another $0.37 million for Canadian visitors to Yukon. These figures are based on an observed 5 percent decline in Yukon population over the 1980-82 period and an observed increase of 5 percent in tourist visitations and fishing licence sales.

The second form of economic benefit arising from the Yukon sport fishery is the expenditure of tourist dollars in the Yukon and Canadian economies. In 1980, it was estimated that visitors to Yukon spent an average of $55.54 per angler day. These expenditures are made up of a variety of different items (see Table 3.16), with travel costs comprising nearly 30 percent of trip costs. Expenditures on food and package tours represent other major expenditures. In total, non-resident anglers (Canadian and foreign) are estimated to have spent about $2.78 million in Yukon in 1980. This number represents the gross benefits of tourist spending, and does not consider the various costs involved in providing the various goods and services to tourists.

Benefits to the Canadian economy come in the form of expenditures by non-Canadians. For 1980, spending by non-resident anglers is estimated to have been about $1.47 million. Again, this figure represents the gross benefits of the sport fishing industry to Canada.

Spending by visiting anglers in 1982 is somewhat higher than the estimates indicated above. Based on licence sales information and discussions with Tourism Yukon, the number of non-resident anglers is estimated to have increased by about 5 percent. In addition, prices have risen considerably over the 1980-1982 period. Information from the Economic Research and Planning Branch of the Yukon Territorial Government shows an average 30 percent rise in consumer prices during this period. On this basis the gross benefits of the Yukon sport

Table 3.16 DISTRIBUTION OF SPENDING BY VISITING ANGLERS, 1980

ITEM	PROPORTION OF SPENDING
Lodging	6.0%
Campsite Fees	2.4%
Package Tours	26.0%
Food	19.5%
Travel Costs	27.5%
Boat Rentals	1.2%
Fishing Supplies	4.1%
Bait	0.3%
Household Owned Boat Costs	1.0%
Guide Services	0.2%
Fishing Licences	1.6%
Taxidermy	0.1%
Other	9.9%
TOTAL	100.0%

Source: Department of Fisheries and Oceans,
1980 Survey of Sportfishing in Canada
Final Results

fishery are calculated to be $3.79 million for the Territorial economy, of which $2.01 million represents benefits to the Canadian economy.

Expenditures by resident sport fishermen provide a third type of economic benefit. This spending, while it adds no monies to the Yukon economy, does provide employment and income benefits for those companies supplying supplies and services to anglers. The magnitude of these benefits are very difficult to measure, however, and will not be considered here.

Employment benefits resulting from the sports fishery are difficult to estimate as many of the goods and services used by non-resident anglers are also used by tourists who don't fish. Consequently it is nearly impossible to identify the number of jobs directly attributable to the sport fishery. However, using information on expenditures by anglers and tourists it is possible to indirectly calculate the employment benefits attributable to sport fishing. Using 1980 statistics, spending by anglers ($2.78 million) contributed about 7 percent of the total expenditures of $38 million recorded for the Yukon tourist industry. With total employment in the tourist industry accounting for about 1,850 jobs, it is possible to say that sport fishing accounted for 130 jobs (7 percent of the total).

In summary, the Yukon sport fishery provides two types of economic benefits. User benefits enjoyed by Yukon and Canadian anglers amounted to about $1.48 million and $0.37 million, respectively in 1982. Similarly, expenditures by visiting anglers provided gross benefits to the Yukon economy of about $3.79 million, while the Canadian economy enjoyed $2.01 million in tourist spending. Based on these expenditures, it is likely that sport fishing activities in Yukon in 1982 were responsible for the creation of 130 seasonal jobs in the tourist industry.

e) Future sport fishing benefits

Predictions of future benefits from the sport fishery must consider both the continued supply of sport fishing opportunities and the demand for sport fishing by all user groups. On the supply side, Paish (1980) has noted that despite increases in angler activity, catches of sport fish appear to be declining over time. These declines are due to the slow growth rates for freshwater sport fish and the steadily increasing demand. Without major changes in fisheries management, it is suggested that sport fish catches will continue to deteriorate, eventually leading to the closure of many areas.

Resident demand for sport fishing will be based largely on population growth rates. In the past, population growth in Yukon has been steady at about 3 percent per year, but this situation has changed significantly in the past years. The decline of the mining industry has resulted in major reductions in employment and population levels.

Recent forecasts by the Yukon Economic Research and Planning Branch predict an annual decline in population of about 9 percent between 1981 and 1983, resulting in a population in 1983 of about 21,000 people. Long term population growth predictions are not available, but future growth is clearly dependent on future economic growth, particularly in the mining and tourism sectors.

Non-resident demand for sport fishing is directly related to the development of the tourism industry, which is dependent on a variety of factors including gasoline prices and foreign exchange rates. Over the past decade, growth in the tourism industry has varied considerably showing a big drop in the mid - 1970's with a major increase in visitations since. Overall, an annual 2 percent rate of growth can be calculated based on fishing licence sales to non-residents.

To predict future benefits from the Yukon sport fishery two scenarios have been developed. The first scenario is based on continuation of the current situation. It is assumed that tourism would continue to

grow at a rate of 2 percent per year throughout the forecast period, and that non-resident angling activities would also grow at a similar rate. Resident angling is also forecast to increase at a rate of only 2 percent per year. This is based on the assumption that full economic recovery in Yukon will only be achieved after a long period of time and that the population growth rates will only be between 1 and 2 percent for the forecast period. Under a more optimistic scenario it is assumed that the tourism industry would increase much more rapidly and that this would, in turn, improve economic prospects in Yukon thereby increasing employment and population at a faster rate. This scenario assumes a 4 percent rate of growth for both resident and non-resident angling activities.

Using these assumptions, the present value of future sport fishing benefits has been calculated below using a variety of discount rates for each scenario.

Present Value of the Sport Fishery
(million 1983 $)

SCENARIO	Discount Rates 5%	10%	15%
Status Quo			
- Consumer Surplus Benefits	48.07	20.32	13.08
- Tourist Expenditures	123.18	52.07	33.53
Optimistic			
- Consumer Surplus Benefits	90.30	26.95	15.46
- Tourist Expenditures	231.40	69.07	39.62

The values shown above describe the benefits to Yukon only.

Compared to the other fisheries a slightly different approach has been taken to determine the employment benefits attributable to the sport fishery. This is necessary due to the assumptions that tourist expenditures are expected to rise throughout the forecast period, and that employment would increase in direct proportion to changes in

expenditures. For example, under the status quo scenario, an annual 2 percent increase in tourist spending would cause employment attributable to sport fishing to increase from 130 seasonal jobs in 1982 to 350 jobs at the end of a 50 year period. Similarly, a 4 percent rate of growth in tourist spending, as assumed under the optimistic development scenario for the sport fishery, would result in 925 jobs at the end of a similar period of time. Average employment during this 50 year period is then assumed to be 227 seasonal jobs per year under the status quo scenario and 415 jobs per year for the optimistic scenario. These average measures are used in the remainder of this analysis in order to determine the impacts of the proposed placer mining guidelines on total employment in the Yukon fisheries.

3.6 Importance of Fisheries Resources to Yukon

There are a number of different ways to measure the contributions to the Yukon economy made by exploitation of anadromous and freshwater fisheries resources. The economic value of the fishery can be assessed by examining the income generated by the commercial and the sports fisheries, plus the user benefits experienced by native, domestic and sports fishermen. Fisheries exploitation also results in various employment benefits for Yukoners. Both types of benefits - economic values and employment - are considered in the following sections.

a) Economic values

Based on the analyses presented in the preceding sections of this chapter, it is now possible to make some general statements about the value of fish resources to Yukon. In 1982 the overall gross value of Yukon fisheries is estimated to have been about $6.54 million, disaggregated as follows:

Commercial fishery	$ 400,160
Domestic fishery	180,190
Native fishery	687,070
Sport fishery	
Consumers' surplus	1,479,150
Gross expenditures	3,790,605
Total	$6,537,175

In examining this value data, it must be remembered that two different types of economic benefits have been combined. Actual sales of goods and services represent one type of economic benefit, and this applies to commercial sales of fish plus expenditures by non-resident anglers. Commercial receipts attributable to Yukon fisheries totaled about $4.15 million in 1982 and this represents only about 1 percent of Gross Territorial Product (GTP). These estimates are not particularly accurate estimates of the real value of Yukon fisheries resources, however, in that the costs of catching fish and providing services for anglers should be deducted to indicate the net contribution to the Yukon economy. Unfortunately, details of the operating costs of commercial fishermen and the variety of tourist services affected by anglers are not available. Given these circumstances most of the remaining analysis is conducted on the basis of the gross value of the fishery.

The second type of economic benefit arising from Yukon fisheries can be thought of as user benefits. These include the consumer surplus benefits enjoyed by Yukon anglers plus the value of the catch taken in the domestic and Indian subsistence fisheries. Such benefits are considered as "extra-market" benefits and are consequently not included in any measure of economic productivity (such as GTP). For 1982, user benefits attributable to the Yukon fishery were in excess of $2.35 million. Again, this measure of fisheries benefits does not take the operating costs of domestic and Indian fishermen into consideration, thereby overestimating the true measure of benefit arising from the fishery. Lack of knowledge about these costs prevents further refinement of the value estimates.

From the foregoing analysis the sport fishery is recognized to be the most economically significant component of Yukon fisheries, representing 80 percent of gross fisheries values. The native subsistence fishery rates second in economic importance, with the commercial and domestic fisheries ranking third and fourth, respectively.

Table 3.17 SUMMARY OF FUTURE YUKON FISHERIES VALUES
(millions of 1983 $)

Status Quo Scenario	Discount Rate 5%	10%	15%
Commercial Fishery	$ 10.20	$ 4.89	$ 3.28
Domestic Fishery	4.59	2.20	1.48
Native Fishery	17.51	8.39	5.64
Sport Fishery			
- Consumer Surplus Benefits	48.07	20.32	13.08
- Tourist Expenditures	123.18	52.07	33.53
TOTAL	$203.55	$ 87.89	$ 57.01
Optimistic Scenario			
Commercial Fishery	$ 20.90	$ 10.02	$ 6.74
Domestic Fishery	9.18	4.40	2.96
Native Fishery	35.02	16.79	11.29
Sport Fishery			
- Consumer Surplus Benefits	90.30	26.95	15.46
- Tourist Expenditures	231.40	69.07	39.62
TOTAL	$386.80	$127.23	$ 76.07

From a Canadian perspective, the measure of economic benefits is slightly different. Consumer surplus benefits experienced by Canadian anglers visiting Yukon, amounting to $0.37 million in 1982, should be added to the total. Similarily, expenditures by Canadian anglers should be subtracted, on the basis that such expenditures merely represent transfers from one part of the economy to another and do not add anything to the Canadian economy. These changes in calculations provide an estimate of $5.12 million as the measure of the value of the Yukon fishery to the Canadian economy.

Various predictions of future fisheries values have been made in each of the preceding sections. These predictions are in the form of two scenarios of development for each fishery; one scenario is based on the maintenance of current levels of fisheries harvest while the other scenario assumes a higher utilization of fish resources. A summary of the results of these forecasts is presented in Table 3.17. Depending on the choice of development scenarios and discount rates, the present value of future benefits from Yukon fisheries ranges between $57 million and $387 million.

b) Employment

An accurate measure of the employment benefits generated by the Yukon fisheries is very difficult to derive considering that only one portion of Yukon fishermen are directly involved in fishing for purposes of obtaining a cash income. Active licenced commercial fishermen in Yukon in 1982 totalled 61 individuals. However, many of these licenced individuals included family members as part of their harvesting operations. The fish processing industry provided seasonal employment for another 18 people.

Although domestic and native fishermen do not fish for cash incomes, the food they produce represents a form of income in kind. Thus, fishing represents a form of self-employment. In 1982 there were 59 active licenced domestic fishermen and 218 licenced native

Table 3.18 SUMMARY OF ANNUAL EMPLOYMENT BENEFITS ATTRIBUTABLE TO YUKON FISHERIES*

	Status Quo Scenario	Optimistic Scenario
Commercial Fishery		
- Licenced Fishermen	60	130
- Assistants	60-120	130-260
- Processing Plant	18	21
Domestic Fishery		
- Licenced Fishermen	60	80
- Assistants	60-120	80-160
Native Fishery		
- Licenced Fishermen	218	436
Sport Fishery		
- Average Annual Employment in Tourist Industry	227	415
TOTAL	700-825	1,290-1,500

* Expressed in terms of number of seasonal jobs.

fishermen. Again, family members often participated in both the native and domestic fishery.

Employment benefits attributable to the sport fishery are related to angler expenditures on goods and services offered by the Yukon tourist industry. In 1982, these expenditures by non-resident anglers amounted to $2.78 million, which resulted in 130 seasonal jobs in the tourist industry.

Based on the employment figures described above, the Yukon fishery provided jobs for at least 486 individuals in 1982, calculated as follows:

Commercial fishermen	61
Domestic fishermen	59
Native fishermen	218
Sports fishery component of employment in tourist sector	130
Fish processing plant	18
Total	486

Of course these figures do not include the assistance of family members in the commercial, domestic and native fisheries. Assuming 1 to 2 assistants per licenced fishermen, actual participation in the fishery could have totalled between 600 and 730 jobs in 1982.

In considering these employment figures it must be remembered that fishing, in most cases, is a seasonal occupation lasting only 2 or 3 months. Salmon fishermen only work during periods of salmon runs - July to September. Many freshwater commercial, domestic and native fishermen fish through lake ice during winter months. Similarly much of the employment in the tourist sector occurs during the late spring and summer. Due to insufficient knowledge about the seasonality of this employment, it is not possible to determine the actual number of man-years of employment attributable to Yukon fisheries resources.

The extent of future employment benefits arising from Yukon fisheries depends on the eventual development of each fishery. Using the development scenarios for each fishery, as identified earlier in this chapter, estimates of these future employment benefits are summarized on Table 3.18. Assuming that fisheries development remains at or near current levels of utilization - the status quo scenario - the annual employment benefits attributable to the Yukon fishery would range between 700 and 950 seasonal jobs per year. Under a more optimistic development scenario that includes a doubling of salmon harvests, fisheries-related employment would average between 1290 and 1500 seasonal jobs per year.

3.7 International Significance of Yukon Fisheries Resources

While Yukon salmon stocks provide a major source of benefits for commercial, domestic, native and sport fisheries in Yukon, a number of other countries also benefit. For example, chinook salmon runs in the Yukon River system are harvested by Yukon, Alaskan and Japanese fishermen. Commercial harvest data for the chinook salmon fishery suggest that, based on 10 year average harvest figures, Alaskan fishermen catch about 110,000 chinook per year while the Japanese and Yukon fishermen catch about 50,000 and 5,000 chinook, respectively. Thus, Yukon fishermen are responsible for only about 3 percent of the total commercial chinook salmon harvest attributable to the Yukon River basin.

Of course not all salmon from the Yukon River basin are produced in Canadian waters. Discussions with Alaskan and Canadian biologists indicate that about 50 percent of the Yukon River chinook runs and 50 percent of the fall Yukon River chum runs are produced in the Yukon Territory. By comparing harvest data to this production information it then appears that Yukon salmon provide substantially more economic benefits to foreign fishermen (Alaskan and Japanese) than to Yukon fishermen.

Normally, the extra-territorial benefits of a salmon fishery would not be considered in an assessment of the economic importance of a particular fishery. However, in light of a proposed treaty between Canada and the United States that includes consideration of salmon production and harvesting in trans-boundary rivers, some discussion of these extra-territorial benefits is warranted. One of the main components of this treaty is the approval of a methodology for allocating salmon harvests between Canadian and U.S. fisherman according to the proportion of the salmon runs originating in each country. In developing this methodology, the treaty recognized the following principles:

> "a) prevent overfishing and provide for optimum production; and
>
> b) provide for each Party to receive benefits equivalent to the production of salmon originating in its waters."
>
> (Article III, paragraph 1)

Based on these principles, the treaty proposes the following allocation formula:

> "...37.5 percent of the harvest by the United States of each species of salmon originating in Canadian sections of trans-boundary rivers, except those with mouths situate in the Bering Sea and Arctic Ocean, shall be deemed to be of United States origin."
>
> (Annex IV, Chapter 1, paragraph 1)

This means that Canadian fishermen exploiting salmon stocks from the Alsek River system and other Pacific drainages would be entitled to harvest 62.5 percent of the salmon produced in Canadian waters. The treaty also recognize the commitment of both the Canadian and U.S. governments to provide salmon for native subsistence fisheries; consequently, the allocation formula applies to salmon populations net of native use. While the proposed treaty and its allocation proposals

Table 3.19 HARVESTS OF YUKON RIVER BASIN SALMON BY ALASKAN AND YUKON FISHERMEN, 1980 - 82

	Alaska			Yukon			Total Harvest	Yukon % of Total
	Commercial	Subsistence	Total	Commercial	Subsistence*	Total		
Chinook Salmon								
1980	155,088	42,724	197,812	9,500	15,500	25,000	222,812	11.2
1981	157,607	29,690	187,297	8,593	8,844	17,437	204,734	8.5
1982	123,658	21,114	144,772	8,640	7,768	16,408	161,180	10.2
Chum Salmon								
1980	298,123	172,657	470,780	9,000	7,000	16,000	486,780	3.3
1981	486,059	188,525	674,584	15,260	6,829	22,089	696,673	3.2
1982	225,021	99,442	324,463	11,312	4,379	14,691	340,154	4.6

* Includes domestic catch

have been initially approved by negotiators for both countries, formal recognition and implementation of the treaty will not occur until ratified by the governments of each country.

At the present time, the Yukon River is not covered under the terms of the proposed treaty, due to insufficient knowledge about the size and distribution of salmon stocks within the Yukon River basin. The treaty calls for the necessary research to obtain this information and for the development of a joint management program for salmon. This, in turn, will lead to a specific allocation formula for Yukon salmon similar in style to the formula proposed for the Pacific salmon fisheries.

For the purposes of this analysis, it has been assumed that the Yukon agreement will be the same as for the other trans-boundary rivers. This assumption makes it possible to estimate the potential value of the credit to be received for Yukon River salmon stocks. A review of total harvests of chinook and fall chum salmon in Yukon and Alaska, including commercial, domestic and subsistence harvests, indicates that currently Yukoners are responsible for about 10 percent of the chinook catch and 5 percent of the fall chum catch - see Table 3.19. Applying the terms of the U.S. - Canada treaty and assuming that 50 percent of each run originates in Yukon, Canada would be credited with 62,500 chinook and 156,250 chum salmon. This credit is far in excess of current harvest levels in Yukon, which are about 20,000 chinook and 20,000 chum per year. Consequently implementation of an allocation agreement patterned after the proposed agreement for other trans-boundary rivers would make another 42,500 chinook and 136,250 chum salmon available for harvest by Canadian fishermen.

There are several different ways of determining the value of this incremental harvest. First, if it is assumed that this additional harvest was made available to commercial fishermen in Yukon, the value of the catch would be determined using the prices paid to Yukon commercial fishermen ($1.87 per kilogram for chinook and $0.66 per kilo-

gram for chum). On this basis, the value of the incremental harvest would be about $1.01 million (1982$).

As a second method of evaluating the worth of the Yukon salmon credit, Alaskan fish prices could be used. This approach indicates the cost of the agreement in terms of lost gross revenues to Alaskan fishermen assuming that the additional catch is taken by Canadian fishermen. Alternatively, this measure of value represents the amount of compensation that Alaska could pay to Canada in order to continue harvesting salmon at current levels. Using 1981 prices ($2.62 per kilogram for chinook and $1.08 for chum - Alaska Department of Fish and Game) and converting to Canadian dollars, the value of the incremental catch is estimated to be about $1.80 million.

One additional method for determining the value of the incremental salmon harvest assumes that the Yukon salmon credit is harvested from a different fishery. For example, it may be advantageous for Canadians to let the Alaskans continue to catch Yukon salmon at current levels but apply the credit to another fishery on the west coast. The value of the increment under these circumstances would be the landed value of the catch in British Columbia, which averaged $4.85 per kilogram for chinook and $1.59 for chum in 1981. Thus, the Yukon salmon credit would be worth about $2.56 million if the credit were applied to the Pacific coast salmon fishery.

In summary, the signing of an allocation plan for Yukon River salmon could significantly add to the value of the overall Yukon fishery. The incremental value of the Yukon salmon credit could range between $1 million and $2.5 million annually (1982 $). And, had the policy been in place in 1982, the overall value of Yukon fisheries resources would have totalled in excess of $7.5 million and perhaps as high as $9 million. The present value of future fisheries benefits arising from such an allocation plan for Yukon River salmon are identified below, according to the three different methods for determining the value of the Yukon salmon credit.

Present Value of the Yukon River Salmon Credit
(millions 1983 $)

Method of Calculation	Discount Rates		
	5%	10%	15%
Yukon Salmon Prices	25.65	12.30	8.27
Alaska Salmon Prices	37.65	18.05	12.14
Pacific Coast Salmon Prices	65.18	31.25	21.01

Such benefits would add substantially to the overall value of the Yukon fishery.

CHAPTER 4

IMPACT OF PROPOSED GUIDELINES ON THE YUKON PLACER MINING INDUSTRY

4.1 Effects of Guidelines on the Yukon Placer Mining Industry

The purpose of this chapter is to estimate the effects of the proposed guidelines on the placer mining industry. The question is: can placer mining operators meet the appropriate standard? What will it cost to achieve these standards and what are the chances that some operators will be unable to meet the guidelines and have little choice but to go out of business?

It should be noted that the values of placer mining activity and the decrease in gold production as calculated in this study represent the gross income from placer mining activities. While it is often more appropriate to assess the net costs of primary and secondary impacts, no detailed data exists to make such calculations.

a) Risk model

It is highly probable that there may be some operators who will cease mining in a particular area because they will not be able to comply with the guidelines. The probability of small operators in narrow valleys and mining higher classification streams being able to meet the guidelines would appear to be low.

In order to make such an estimate a risk model was developed (Appendix VI) from which it would appear that between 16 and 28 percent of operators might face a very high level of risk, the worst possibility of which is being forced to quit placer mining. The risk model has been built in a way that it shows the proportion of mining operation that will have great difficulty in meeting the guidelines, mainly because they are mining narrow valleys and have to meet the most stringent effluent standards according to their stream classifications. The model does not attempt to account for those operators who, upon ceasing operations at one location, are able to relocate.

The gap of 16 to 28 percent can be explained because some concerns have been expressed about the relevance of the "size of operation" factor for the following reasons:

1. Experience shows that many smaller operations are more viable than large.
2. Smaller operations have greater flexibility in method of water use.
3. Small operations in a narrow valley may have as much ability to operate as a large operation in a wide valley.

Also the "percentage of operators mining narrow valleys" is another very sensitive assumption since it has been considered to be a major factor and weighted accordingly. So, in order to meet all of these concerns, a sensitivity analysis has been developed around these two factors. The risk model was done four times using the same methodology as explained in Appendix VI, with the following assumptions:

1. Using four factors, and assuming 75 percent of operations are in narrow valleys.
2. Using four factors and assuming 50 percent of operations are in narrow valleys.
3. Using three factors (stream classification, time in business, valley width), and assuming 75 percent of operations are in narrow valleys.
4. Using three factors and assuming 50 percent of operations are in narrow valleys.

The respective results were as follows: 23, 16, 28 and 19 percent of operators will be facing a very high level of risk, and may be forced to quit placer mining or relocate mainly because they are mining narrow valleys and have to meet a 100 mg/l standard for their effluent.

TABLE 4.1 DECREASE IN PRESENT VALUE OF FUTURE GOLD PRODUCTION FOR THE PLACER MINING INDUSTRY

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
- Decrease per year in 1983 CDN $ (million)	2.0	12.0
- Present value (million $) 1983-1995		
a) discount rate 5%	19.7	118.4
b) discount rate 10%	15.6	93.8
c) discount rate 15%	12.8	77.0

TABLE 4.2 DECREASE IN FUTURE EMPLOYMENT FOR THE PLACER MINING INDUSTRY

(annual man years)

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
Direct employment	20-24	48-56
Indirect employment	10-12	24-28
TOTAL EMPLOYMENT	30-36	72-84

b) Assessment of decrease in placer mining activity

Among the four possibilities developed in the risk model, the one which shows the lowest impact (16 percent of placer mining operators out of business or relocated) has been chosen. Tables 4.1, 4.2 and 4.3 illustrates what the impact would be of a 16 percent decrease in the placer mining industry in terms of income for the placer mining industry, employment and secondary impacts.

The present situation shows the following distribution among placer miners who will have to meet the 1,000 mg/l, 100 mg/l and 0 mg/l effluent standards. (Appendix VI).

Standard	Distribution
0 mg/l	2.2 %
100 mg/l	47.8 %
1,000 mg/l	50.0 %

Since operators who may have to leave the placer mining business or relocate are most likely those who have to meet the 0 mg/l and the 100 mg/l effluent standard (mainly because they are mining narrow valleys) it has been assumed that in the future (using numbers shown in the risk model - Appendix VI), the distribution may become the following:

Standard	Distribution
0 mg/l	0.9 %
100 mg/l	39.8 %
1,000 mg/l	59.3 %

4.2 Costs for operators remaining in business

The first task is to estimate for each scenario, what the number of operators may be. The number of operators for each scenario was estimated by looking at the recent history of the industry. There were 175 operators in 1978; since then the number of operators has increased to somewhere in the range of 200 to 250. It has been assumed that, depending on the particular scenario, there will be between 150

TABLE 4.3 DECREASE IN PRESENT VALUE OF FUTURE SECONDARY IMPACTS OF THE PLACER MINING INDUSTRY

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
- Decrease per year 1983 CDN $ (million)	0.8	4.8
- Present value (million $) 1983-1995		
a) discount rate 5%	7.9	47.3
b) discount rate 10%	6.3	37.5
c) discount rate 15%	5.1	30.8

and 300 operators. If the proposed guidelines decrease the number by 16 percent, there will be 126 to 252 mining operations which would choose to incur the four major costs associated with the proposed guidelines:

a) building settling pond systems that can achieve the standards;
b) building stream diversions to engineered specifications, if required;
c) rehabilitation of the worked areas.
d) recontouring the tailings to meet the contour of the valley walls.

a) Settling ponds

There are three levels of standards that operators will have to achieve according to their stream classification and they are:

- 1,000 mg/l
- 100 mg/l
- 0 mg/l

A technical brief entitled "The Attainment and Cost of Placer Mining Effluent Guidelines", prepared by the DOE and DFO, proposed methods and costs for the achievement of guideline effluents standards.

Cost estimates are based on a "typical" small placer operation that sluices 70 cubic yards per hour, using 4,000 gallons of water per minute and sluicing 7.5 hours/day for 90 days. None of these examples consider the treatment of washings from ground sluicing.

i) 1,000 mg/l standard

To achieve this standard two types of pond are proposed, a primary or recycle pond to settle fine sands and coarse silt, and a secondary pond for fine silts and clays. Table 4.4 shows the estimated costs of constructing those two ponds depending on the type of bulldozer used. The total cost would be between $4,000 and $8,000.

TABLE 4.4 COST OF SETTLING PONDS TO ACHIEVE 1,000 mg/l

	EQUIPMENT TYPE					
	D7G	D7E	D8L	D8H	D9L	D9D
Cost of primary pond*	$ 2,860	3,050	2,050	1,850	1,780	1,510
	2,860	3,050	2,050	1,850	1,780	1,510
Cost of secondary pond	$ 1,834	2,000	1,392	1,157	1,125	1,000
Total Cost of Settling Pond System	$ 7,554	8,100	5,492	4,857	4,685	4,020

* In the technical paper entitled "The Attainment and Cost of Placer Mining Effluent Guidelines", the example calls for using the primary pond for 45 days sluicing production at 7.5 hours/day. After that time, it has to be cleaned out, or a second one must be built. This is why costs of the primary pond are doubled.

ii) 100 mg/l standard

In order to achieve this standard a recycle system will have to be added to the two-pond settling system, and it has been estimated that the total cost will be between $17,000 and $33,000 as shown in Table 4.5.

iii) 0 mg/l standard

Because a second recycle pump will be required, the cost to achieve the 0 mg/l is believed to be $12,000 more than for the 100 mg/l standard and it has been estimated that the total cost should be between $29,000 and $45,000.

iv) The typical cost

As shown in section 4.2b, the distribution of operators who will have to meet the 1,000 mg/l, the 100 mg/l and the 0 mg/l effluent standard is respectively 59.3, 47.8 and 0.9 percent. By using the weighted average with the associated cost, the calculations* show a typical operation using 4,000 i.g.p.m. to sluice 70 cubic yards per hour for a season of 90 days sluicing production at 7.5 hours per day will have to spend $10,700 to $21,000 in order to achieve the effluent standard prescribed by the proposed guidelines.

Table 4.6 shows the distribution of water use by placer miners according to the water use authorizations issued in 1982. From that table the weighted average of flow rate is determined to be 2,600 i.g.p.m. and then if a direct relation between settling pond cost and

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*

Distribution of Operations	Range of Costs	Total Costs
0.9%	$29,000 - $45,000	$ 260 - $ 405
47.8%	$17,000 - $33,000	$ 8,126 - $15,774
59.3%	$ 4,500 - $ 8,000	$ 2,372 - $ 4,744
Typical Cost		$10,758 - $20,923

TABLE 4.5 COST FOR ACHIEVING THE 100 mg/l STANDARD

	EQUIPMENT TYPE	
	D7E	D9L
Cost of primary pond[a]	$ 3,050 3,050	1,780 1,780
Cost of secondary pond	$ 4,074 - 10,373	2,009 - 5,115
Cost of pump[b]	$ 10,800 - 15,300	10,800 - 15,300
Total Cost	$ 20,974 - 31,773	16,369 - 23,974

a See Note, Table 4.4

b The pump costs were estimated at:

- operating $ 42/day
- financial $ 78/day
  $ 120/day

assuming a $17,000 pump system for 50% recycle, pumping 2,000 i.p.g.m.

- operating $ 67/day
- financial $ 103/day
  $ 170/day

assuming a $20,500 pump system, for 87% recycle pumping 3,500 i.p.g.m.

TABLE 4.6 FLOW RATE AND NUMBER OF WATER USE AUTHORIZATIONS - 1982

FLOW RATE (i.g.p.m.)	NUMBER OF OPERATORS*	
1,000	18	12%
1,500	20	13%
2,000	35	23%
2,500	18	12%
3,000	28	18%
3,500	15	10%
4,000	7	5%
4,500	2	1%
5,000	8	5%
5,500	1	1%
6,000	2	1%
8,000	1	1%
	155	

* Those who used less than 1,000 i.g.p.m. and those who used the total stream are not included.

Note:

This information is obtained from individual miner's application for water authorizations. Actual quantities used may be greater.

TABLE 4.7 PRESENT VALUE OF THE INCREMENTAL COSTS OF SETTLING PONDS

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
- Number of operators	126	252
- Incremental total cost per year 1983 CDN $	$200,000-643,000	$400,000-1,300,000
- Present Value (Million $) (1983 - 1995)		
a) discount rate 5%	$2.0 - 6.3	$3.9 - 12.8
b) discount rate 10%	$1.6 - 5.0	$3.1 - 10.2
c) discount rate 15%	$1.3 - 4.1	$2.6 - 8.3

TABLE 4.8 PRESENT VALUE OF THE INCREMENTAL COST OF DIVERSIONS

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
Incremental total cost per year 1983 CDN $	$ 22,500 - $ 90,000	$ 45,000 - $ 180,000
Present Value 1983-1995		
a) discount rate 5%	$222,000 - 888,000	$444,000 - 1,800,000
b) discount rate 10%	$176,000 - 700,000	$352,000 - 1,400,000
c) discount rate 15%	$145,000 - 578,000	$290,000 - 1,200,000

flow rate is assumed, the average cost per operator to achieve the standard will be $7,000 to $13,700.

v) The incremental cost

In order to assess the incremental cost of settling facilities, it is necessary to know what is actually spent by the operator. However, most operators do not have a sophisticated accounting system and they cannot state with certainty how much they spend for a specific component or activity. What they do know, however, is the total cost of their operation. Interviews with people related to the industry (from miners to government officials) indicate that most miners know, for a season, what their overall costs might be in dollars per cubic yards of sluiced paydirt, and they also have a rough assessment of the gold content of their paydirt and therefore their gross income but none of the people contacted were able to give an actual settling pond cost, and since this analysis is concerned with the incremental costs, some estimates must be made.

It is known that most operators now have some form of settling pond, but many are ineffective and would require rebuilding to bring them up to optimum operating efficiency. To obtain some idea of the incremental costs that the industry may be facing, it has been assumed that the cost of improving the settling ponds from what they are at present to optimum efficiency is somewhere between 30 and 60 percent of their present cost. The incremental cost per operator then will be between $1,600 and $5,100.

Table 4.7 shows the total incremental cost that may have to be incurred to build a satisfactory settling pond.

b) **Diversion**

The incremental cost related to diversions is the cost of having the diversion designed by professional engineers. It should be

TABLE 4.9 PRESENT VALUE OF COSTS OF REHABILITATION*

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
yds^3/year (millions)	.75 - 1.2	1.5 - 2.3
Total cost of rehabilitation/year 1983 CDN $ (millions)	$0.25 - 0.4	$1.5 - 0.75
Present value (million $) 1983 - 1995		
a) discount rate 5%	$2.5 - 3.7	$5.0 - 7.4
b) discount rate 10%	$2.0 - 3.0	$4.0 - 5.7
c) discount rate 15%	$1.6 - 2.5	$3.2 - 4.8

* Those costs represent an expense of approximately $2,500/year/operator.

noted, however, that there will undoubtedly be extra construction costs. No attempt has been made to estimate these costs as the information required was not available.

From a survey of engineering consultants it was determined that the design cost should be between $2,500 and $10,000. The construction costs are very difficult to estimate; they are basically related to the length of the diversion, the flow of the stream, and the flood event (10:1 or 5:1) it must contain.

Since only operators on C streams would be required to have a professional engineering design for diversions, the incremental costs will affect (see Appendix VI) 15 percent of the operators remaining in business. In considering the number of operators who will require diversions, the Sigma Report stated:

> "Stream diversions are necessary for flood protection for those mines located in the present stream channel. Although the number of operations utilizing diversions is not provided by the water use information files a large portion would require diversion." (p.2-28)

It is not known what constitutes a large portion, however, it has been assumed that 50 percent will require diversions. Depending on the scenario there will be between 9 and 18 operators* who will require diversions at an incremental cost of between $2,500 and $10,000. Table 4.8 shows the total incremental costs resulting from building diversion (C class only) to engineered specification.

c) Rehabilitation

According to the proposed guidelines, rehabilitation of the worked areas will require covering the disturbed part of the claim with 10 cm of top soil. Operators will also have to recontour tailings.

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* High gold price scenario: 252 x 15% x 50% = 18 operators
Low gold price scenario: 126 x 15% x 50% = 9 operators

TABLE 4.10 PRESENT VALUE OF COSTS OF RECONTOURING

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
Number of operators	126	252
Cost per year per operator	$ 6,000 - 12,000	$ 6,000 - 12,000
Total cost of recontouring/year 1983 CDN $ (million)	$0.8 - 1.5	$ 1.6 - 3.0
Present Value (millions $) 1983 - 1995		
a) discount rate 5%	$7.9 - 14.8	$15.8 - 32.6
b) discount rate 10%	$6.3 - 11.7	$12.5 - 23.4
c) discount rate 15%	$5.1 - 9.6	$10.3 - 19.6

The assessment of costs for topsoil covering is based on the assumption that between 500,000 and 750,000 square feet per mining operation will have to be covered with topsoil each year (DIAND, personal communications). The total amount (yards^3) of topsoil that will have to be moved each year can be calculated (see Table 4.9).

Once the number of cubic yards of topsoil to be moved in order to rehabilitate the mined areas is known, the associated costs can be assessed. Since the majority of operators use a D-8 CAT, the average cost for moving topsoil can be calculated as follows:

	D8L	D8H
yards/hour	501	286
$/hour	174	89
$/yard	0.35	0.31
Average $/yard	0.33	

Using these figures, the cost for rehabilitation for each scenario will be those identified in Table 4.9.

d) <u>Recontouring the tailings to meet the contours of the valley walls</u>

According to paragraph 1.2 of the general guidelines, miners will have to recontour their tailings and other materials to meet the contour of the valley walls. The cost related to this specific requirement are quite different to assess because they are very site specific and depend on the amount of ground that has to be removed before reaching the paydirt. However, it has been estimated and assumed (DIAND, personal communications) that, on the average, it will require one week per operator to meet that specification. Thus, the cost per operator may be:

$$7 \text{ days} \times \frac{10 \text{ hours}}{\text{day}} \times \frac{\$89 - \$174^*}{\text{hour}} = \$6,230 - \$12,180$$

Total costs for recontouring are summarized in Table 4.10

4.3 Other Costs

This review of the costs of the proposed guidelines is not complete. There are a number of other costs which have not yet been considered. Although these costs are not examined in detail, but some general comments are in order.

a) Development plan

This is not expected to be a major expense item for most operators and presumably those who decide to continue mining would be able to amortize it over a number of years. For some operators there could be large costs involved. However, the costs of a development plan are difficult to estimate. If such a plan is done professionally it could cost up to $10,000, and this amount is exclusive of any physical exploration that may be required.

b) Baseline environmental data

For those operators who wish to challenge the stream classification of their area, there will be the added cost of gathering the baseline environmental data. It is believed that the number of operators who wish to challenge their classification will be quite small. Therefore, incremental costs of gathering such data will be

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* The costs of bulldozing are developed in the technical brief that has been used to assess the cost of settling ponds, entitled "The Attainment and Cost of Placer Mining Effluent Guidelines".

relatively insignificant. It is expected that most of the challengers would probably come from those operating in A, B and C stream and, as noted in the development of the risk model (Appendix VI), there is considerable risk that some of these operators will leave the placer mining industry or relocate to another area.

c) "Lost gold"

There are conditions of the proposed guidelines that will effectively prevent the recovery of some placer gold. Prohibition of diversions on A and B streams will mean that gold deposits in the beds of such streams simply cannot be recovered. Similarly, the requirement of leave strips will also result in "lost" deposits.

No attempt has been made to estimate the value of this "lost gold". Since operators on such streams face the greatest risk of not being able to comply with the guidelines there is a good probability that most of these operators will decide not to mine their properties. The number of operators that would try to mine A and B streams would be very few in number; only six percent of current operations are located on A and B streams.

4.4 Summary of Impacts on Placer Mining Industry

a) Allocative impacts

As determined by the assumptions and calculations in the preceding analysis, the total cost of the proposed guidelines on the Yukon placer mining industry is shown on Table 4.11. Depending on the development scenario for placer mining and the choice of an appropriate discount rate, the additional costs of the guidelines would range from $20 million to $170 million.

TABLE 4.11 TOTAL COSTS OF THE PROPOSED GUIDELINES*

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
	(millions $)	(millions $)
A) Discount rate 5%		
- Decrease in placer mining gold production	19.7	118.4
- Settling pond	2.0 - 6.3	3.9 - 12.8
- Diversion	0.22 - 0.9	0.44 - 1.8
- Rehabilitation	2.5 - 3.7	5.0 - 7.4
- Recontouring	7.9 - 14.8	15.8 - 32.6
TOTAL	32.3 - 45.4	143.5 - 173.0
B) Discount rate 10%		
- Decrease in placer mining gold production	15.6	93.8
- Settling pond	1.6 - 5.0	3.1 - 10.2
- Diversion	0.18 - 0.7	0.35 - 1.4
- Rehabilitation	2.0 - 3.0	4.0 - 5.7
- Recontouring	6.3 - 11.7	12.5 - 23.4
TOTAL	25.7 - 36.0	113.8 - 134.5
C) Discount rate 15%		
- Decrease in placer mining gold production	12.8	77. 0
- Settling pond	1.3 - 4.1	2.6 - 8.3
Diversion	0.15 - 0.58	0.29 - 1.2
- Rehabilitation	1.6 - 2.5	3.2 - 4.8
- Recontouring	5.1 - 9.6	10.3 - 19.3
TOTAL	21.0 - 29.6	93.4 - 110.9

* All costs are the present value of incremental costs for 1983-1995 period, and are expressed in 1983 CDN $.

b) **Non-allocative impacts**

Under the stated guidelines for SEIA's it is necessary to indicate the non-allocative impacts of any new regulation which in this case are considered to include regional balance, employment and market structure. Those impacts are respectively shown in Tables 4.12 and 4.13.

As shown previously, it is believed that the placer mining activity will be decreased by 16 percent. This means a decrease of between 24 to 48 operators that otherwise might have been placer miners, and leaves the industry with an estimate of 126 to 252 operators instead of 150 to 300.

TABLE 4.12 REGIONAL IMPACT OF THE PROPOSED GUIDELINES

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
- Yearly decrease of secondary impacts - 1983 CDN $ (million)	0.8	4.8
- Present Value (million $) 1983-1995		
a) discount rate 5%	7.9	47.8
b) discount rate 10%	6.3	37.5
c) discount rate 15%	5.1	30.8

TABLE 4.13 EMPLOYMENT IMPACT OF THE PROPOSED GUIDELINES (annual man years)

	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
- Decrease in direct employment	20-24	48-56
- Decrease in indirect employment	10-12	24-28
- Total decrease in employment	30-36	72-84

CHAPTER 5

IMPACT OF NEW GUIDELINES ON YUKON FISHERIES

The purpose of this chapter of the SEIA is to assess the impact of the proposed placer mining guidelines on fish resources and utilization in Yukon. This analysis involves two different steps. As the first step, the current impacts of the placer mining industry on Yukon fisheries are described and quantified in Section 5.1. These impacts on fish resources are assessed using studies by Langer (1980) and Hall and McKay (1982) on the effects of sediment on fish resources, and a study by Mathers, West and Burns (1981) which measured sediment discharges from Yukon Placer mining operations. In addition, the geographical overlap between important areas of fish habitat and the location of placer mining activities is considered. This step of the analysis is of particular importance, as it provides a baseline estimate of existing impacts on fisheries habitat against which the impacts of the proposed guidelines can be measured.

As a second step, the impacts of the proposed guidelines on Yukon fish stocks is assessed by considering the information presented in "A Rationale for the Suspended Solids Standards for Yukon Streams Subject to Placer Mining". This information suggests that implementation of the proposed guidelines would affect fish resources in two different ways. First, existing placer mining operations would be required to reduce sediment levels in discharge waters, thereby allowing rehabilitation of fish habitat and increased fish production in these areas. The second impact will be the protection of fish habitat in areas where placer mining activities may occur in the future. These two types of impact are considered separately (in Sections 5.2 and 5.3). Part of the analysis in each of these sections includes a qualitative estimate of the associated impacts on Yukon commercial, domestic, native and sport fisheries, for purposes of undertaking a benefit-cost comparison of the proposed guidelines in Chapter 6.0.

5.1 Impacts of Placer Mining on Yukon Fisheries

The impacts of placer mining activities on Yukon fisheries resources have never been studied in great detail. In fact, to make a comprehensive study of these impacts would require knowledge of fish populations and distributions prior to the outbreak of the Yukon goldrush in 1896. Such knowledge does not exist, of course, and even today there is much uncertainty as to the extent of fish populations supported by each of the major river drainage systems in Yukon. For the myriad of small creeks and streams in Yukon, knowledge about fish species and their numbers is virtually non-existent. Given this state of understanding of Yukon fisheries resources, a rigorous analysis of the impacts of placer mining cannot be undertaken.

In lieu of a rigorous methodology, a more qualitative approach has been adopted for the purpose of describing the impacts of placer mining on Yukon fisheries. This approach involves a comparison of the fisheries distribution information presented in Figures 3.1, 3.2 and 3.3 with the distribution of placer mining operations (Figure 2.1). By comparing the areal extent of the drainage basins affected by placer mining to the total size of the drainage basins, an approximation of the decline in fisheries productivity can be made. This process is admittedly very crude, and relies on the assumptions that fisheries productivity is directly proportional to the extent of habitat disturbances, and that measures of land area are accurate reflections of available fish habitat. Neither of these assumptions is particularly reliable, but given the lack of information and alternate methodologies for making these calculations, any problems with these assumptions have been ignored.

a) Anadromous species

Placer mining affects anadromous species in three different ways: sedimentation of spawning grounds, direct disturbances of spawning and rearing areas, plus interference with annual migrations. Of the three, sedimentation of spawning grounds represents the most serious problem.

As shown in figure 5.1, salmon spawning areas in Yukon are quite extensive while watersheds affected by current mining operations are concentrated around Dawson and Mayo. On this basis it would appear that only about 5 percent of potential salmon spawning areas in Yukon are located in areas currently affected by placer mining.

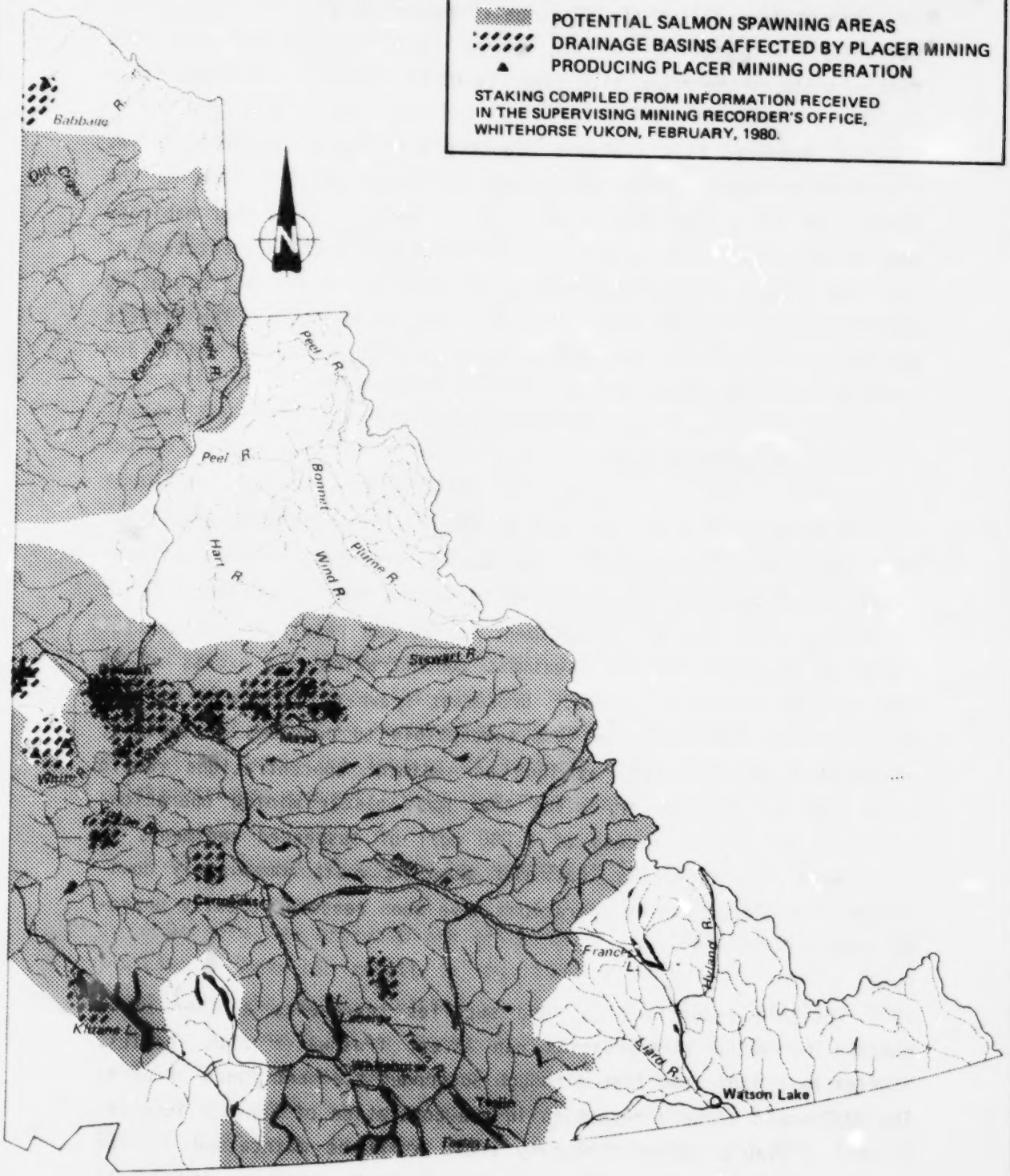
The extent of impacts on spawning grounds in these areas is assumed to be extremely high. A study of 7 placer mines in Yukon by Mathers, West and Burns (1981) found that:

> "Downstream of most placer mines, suspended sediment levels were between 1,000 and 4,000 mg/l during sluicing."

Langer (1980), on the other hand, reports that healthy populations of fish can be maintained when effluent discharges to streams were at or below 25 mg/l. Furthermore, Langer identifies several studies showing that small levels of additional sediments in spawning areas have greatly decreased egg-to-fry survival. For these reasons it is assumed here that all salmon spawning areas immediately below placer mining operations have been rendered unproductive by the effects of sediment. Thus, sedimentation of spawning grounds is concluded to have caused a 5 percent reduction in the potential productivity of Yukon salmon species.

A second type of impact of placer mining operations is the direct disturbance of salmon spawning and rearing grounds. While the extent of such damages is probably significant, the location and extent of these disturbances coincides with the areas affected by sedimentation, as described above. Consequently, the direct disturbance of spawning and rearing areas is assumed to have caused no further reductions in potential salmon productivity.

The effects of suspended sediments on migrating salmon is expected to cause an additional impact on salmon productivity in Yukon. Suspended sediments can cause abrasion of skin and gill surfaces, affect the efficiency of feeding and generally create physiological



YUKON TERRITORY

SCALE 1:5,000,000

FIGURE 5.1

stress. For purposes of this analysis, it is assumed that the impact of sediment from placer mining annually causes an additional 5 percent mortality in migrating fry and adults (combined). This mortality further reduces the productive capacity of the Yukon salmon fisheries.

In summary, this analysis suggests that Yukon salmon fisheries currently produce at only 90 percent of their potential due to the effects of the placer mining industry on water quality and habitat. Half of this reduction is assumed to occur because of sedimentation of spawning grounds, while the impacts of sediment on fry and migrating adults causes a further reduction in salmon populations. The effects of this loss of productive capacity on commercial, domestic, native and sport harvests of salmon is examined in Section 5.2

b) Freshwater species

Freshwater fish species are affected by placer mining activities in a number of different ways. For species like trout and char, sedimentation of spawning areas appears to be the most significant impact given that minor changes in sediment levels can result in substantial increases in egg mortality; sediment concentrations in excess of 25 mg/l are considered dangerous. Broadcast spawners like grayling and whitefish are thought to be less susceptible to problems of sediment affecting spawning areas, as long as sediment concentrations remain below 100 mg/l. However, given that most placer mining operations currently release in excess of 1,000 mg/l of suspended sediments in waste water, it is likely that most spawning areas immediately downstream from placer mining operations have been rendered totally unproductive.

Possible reductions in food supplies represents another means whereby increased sedimentation can affect freshwater fish species. Studies have indicated that although suspended sediment loads of up to 100 mg/l would cause a reduction in the population of benthic invertebrates, a viable stream community could still be maintained. For bottom feeders, like whitefish and burbot, high sediment loads could

make food supplies inaccessible. Increased turbidity would also affect the feeding efficiency of trout, char and grayling. Given the high level of sediments currently poured into streams by placer mining operations, significant impacts on adult freshwater fish have undoubtedly occurred. Benthic communities are severely affected by sediment concentrations in excess of 1,000 mg/l. In addition, fish are more susceptible to disease and undergo changes in feeding behaviour.

The territorial significance of placer mining impacts on freshwater fish species is highly dependent on the species of fish under consideration. For species like lake trout, northern pike, whitefish, grayling and burbot, which are distributed throughout Yukon, the loss of a relatively small amount of habitat has probably had only minor impacts on fish populations. Populations of Arctic char and Dolly Varden have likely been hardly affected at all; most placer mining operations are located outside the main ranges of these species. Impacts on rainbow trout, on the other hand, have probably been more severe due to its limited range which includes areas of placer mining activity.

Overall, it is assumed that only a 5 percent reduction in freshwater fish productivity has occurred because of placer mining. This estimate may appear to be somewhat liberal, but it takes into consideration the cumulative impacts of sediment deposition in lakes which, unlike streams, are not flushed out on an annual basis.

c) Impact of arsenic and mercury pollution

As gold and aresenic are often found in close association, the sluicing process can result in considerable amounts of arsenic being added to waste waters, either as sediment or in a soluble form. Processing of waste waters by use of a settling pond can reduce concentrations by as much as 90 percent, but a significant amount of arsenic is still released into streams and rivers. Although the extent of arsenic pollution in Yukon has not been assessed, the Alaskan

experience shows that arsenic concentration in placer mining effluents discharged into streams ranged from 0.08 mg/l to 0.25 mg/l after processing while the normal level of arsenic in the receiving waters was only 0.006 mg/l (Zemansky, 1981).

Increased levels of arsenic attributable to placer mining have probably had some negative impacts on Yukon fish resources. This problem has never been examined. However, it would appear that given the distribution of placer mining operations and the number of streams involved, the impacts of arsenic poisoning would be noticeable only in area where sedimentation problems have already affected fisheries productivity. For purposes of this analysis, it is assumed that arsenic pollution has had no incremental negative impact on Yukon fish resources.

Although the use of mercury in placer mining appears to be on the decline, mercury contamination of Yukon streams is still considered to be a threat to water quality and fish resources. Mercury is used to separate gold from other materials because of its ability to form an amalgam with gold. It is estimated that placer operators still using the amalgamation process lose between 1 percent and 10 percent of mercury used, depending on the frequency of use and mercury recovery methods (Osler, 1983). Once picked up by water used in the separation process, most mercury settles in the sediments of settling ponds while small amounts remain in suspension and are discharged into streams. In the sediments, this metallic mercury can be converted into various methylated mercury compounds that can be accumulated in the tissues of aquatic organisms and can also be highly toxic.

In Yukon in 1982 it is estimated that 9 percent of placer mining operations used mercury to process gold, and that the total loss of mercury amounted to about 5 kg. Despite this level of emission, no major mercury contamination problems are known to have occurred. Water quality tests undertaken in 1982 (Osler, 1983) found that mercury levels at test sites near placer mines fell at or below detection limits of 0.0002 mg/l. Mercury concentrations in sediments adjacent to

placer mining operations were not measured, but it is assumed that any areas of contamination coincide with areas where sediment problems have also occurred so that the effects of mercury poisoning cannot be readily isolated. Therefore, any mercury poisoning problems associated with the placer mining industry are assumed to have had no impact on Yukon fish resources.

5.2 Habitat Rehabilitation Benefits

If the proposed placer mining guidelines are implemented, a number of existing placer mining operations would be forced to undertake investments in facilities to reduce their sediment discharges. Using the number of placer mining operations active in 1980 as an example: 4 operators would be required to operate at a sediment discharge level of 0 mg/l; 94 operators would have to limit their discharges to 100 mg/l; and the remainder (99) could have 1,000 mg/l of sediment in their waste water discharges. (see Appendix VI). Of course these water quality objectives would not have to be met right away as the guidelines would be phased in over a 5 year period starting in 1984 (see schedule of compliance - Appendix II). Once the ultimate water quality standards are met for those streams with the greatest potential fisheries productivity, it is expected that natural rehabilitation of disturbed fisheries habitat would occur, resulting in the re-establishment of aquatic plants and the eventual return of fish populations.

To quantify the impact that the proposed water quality guidelines would have on the productivity of Yukon fisheries, it is necessary to consider the extent to which placer mining has already affected fisheries productivity. In Section 5.1 was concluded that sediment discharges due to placer mining have led to a 10 percent reduction in potential productivity for salmon species, based on a 5 percent decline due to sedimentation of spawning grounds and a 5 percent higher mortality rate for migrating fry and adult fish. For freshwater species, a 5 percent decrease in productivity was suggested to be attributable to sediment releases by the placer mining industry.

With implementation of the proposed guidelines, it is assumed that the productivity of both salmon and freshwater fisheries would return to maximum levels. The 0 mg/l sediment discharge level for streams with salmon spawning areas would mean that spawning success would return to normal, resulting in the production of more fry and the eventual return of greater numbers of adult fish. Similarly, the spawning success of freshwater species would also return to normal as the 100 mg/l sediment discharge level proposed for such areas should not affect normal egg-to-fry survival rates. Implementation of the guidelines would also mean that the total volume of suspended sediments dumped into Yukon streams and rivers would diminish substantially. Consequently, in major rivers like the Yukon River, the cumulative effect of sediment deposition from numerous tributaries would cease to be a problem, thereby reducing physiological stress on migrating salmon and reducing mortality rates.

In summary, implementation of the water quality guidelines would increase salmon production by 10 percent and freshwater fish populations by 5 percent. The resulting levels of fisheries productivity in Yukon would then be close to the maximum productive capability, barring any stock enhancement programs. The effect of this increased fish production on each of the commercial, domestic, native and sport fisheries is considered in the remainder of this section.

a) Commercial fishery

Assuming no changes in the allocation of salmon species among the four competing Yukon fisheries, a 10 percent increase in salmon productivity would result in a 10 percent increase in the Yukon commercial salmon harvest. In terms of the status quo development scenario for the commercial fishery, this would then mean another 950 chinook salmon and 1,250 chum salmon would be caught by commercial fishermen. It is expected that most of these fish would be sold to the Han Fishery at Dawson; the Han plant has enough capacity to process nearly twice as many fish per day. Although employment activity at the plant (in terms of man-years) would have to increase in order to handle the extra fish,

it is unlikely that the plant would employ any additional people. The number of fishermen active in the salmon fishery might well increase, but even a 10 percent increase would only result in there being 4 additional licenced fishermen, plus 4 to 8 assistants. As most commercial fishing occurs in the Dawson area, and because much of the additional salmon production would come from rehabilitated spawning areas immediately upstream from the Dawson area (see Figure 5.2), nearly all the benefits of the proposed water quality guidelines would be experienced by those commercial salmon fishermen working downstream from Dawson.

For commercial freshwater fishermen, the impact of a 5 percent increase in populations of freshwater fish is also assumed to result in a 5 percent larger harvest. Based on the status quo scenario, the size of this incremental catch would be about 700 fish of mixed species (mainly whitefish). Given this relatively small change in harvest, direct employment in the fishery is not expected to change; existing fishermen would just have a larger catch. It is thought that local markets would easily be able to absorb the additional fish caught. Based on the location of existing placer operations relative to lakes and rivers supporting commercial fishing activity (Figure 5.2), it appears that commercial freshwater fishermen using Mayo Lake and the Yukon River would benefit most from the increase in fish productivity.

For the optimistic development scenario for the commercial fishery, as described in section 3.2, the fisheries benefits attributable to implementation of the placer mining guidelines would be substantially higher. The commercial salmon catch would increase by about 4,400 pieces and another 1,750 freshwater fish of various species would be harvested annually. Given these greater levels of harvest it is expected that another 26 to 39 people would be seasonally employed in the commercial fishery: 13 as licenced fishermen and another 13 to 26 as assistants. No additional jobs in fish processing would be involved because both the Han Fishery and the proposed freshwater fish processing plant would have sufficient capacity to handle the incremental catch by simply extending the period of operation.

Implementation of the proposed guidelines would produce a long term benefits for the Yukon commercial fishery resulting from the rehabilitation of streams currently affected by placer mining. Using the two development scenarios for the commercial fishery and assuming that the long term productivity of Yukon fish resources remains at 10 percent above current levels for salmon species and 5 percent above current levels for freshwater species, the present value equivalent of the incremental commercial fisheries values attributable to the proposed guidelines can be determined. The results of this analysis are presented below:

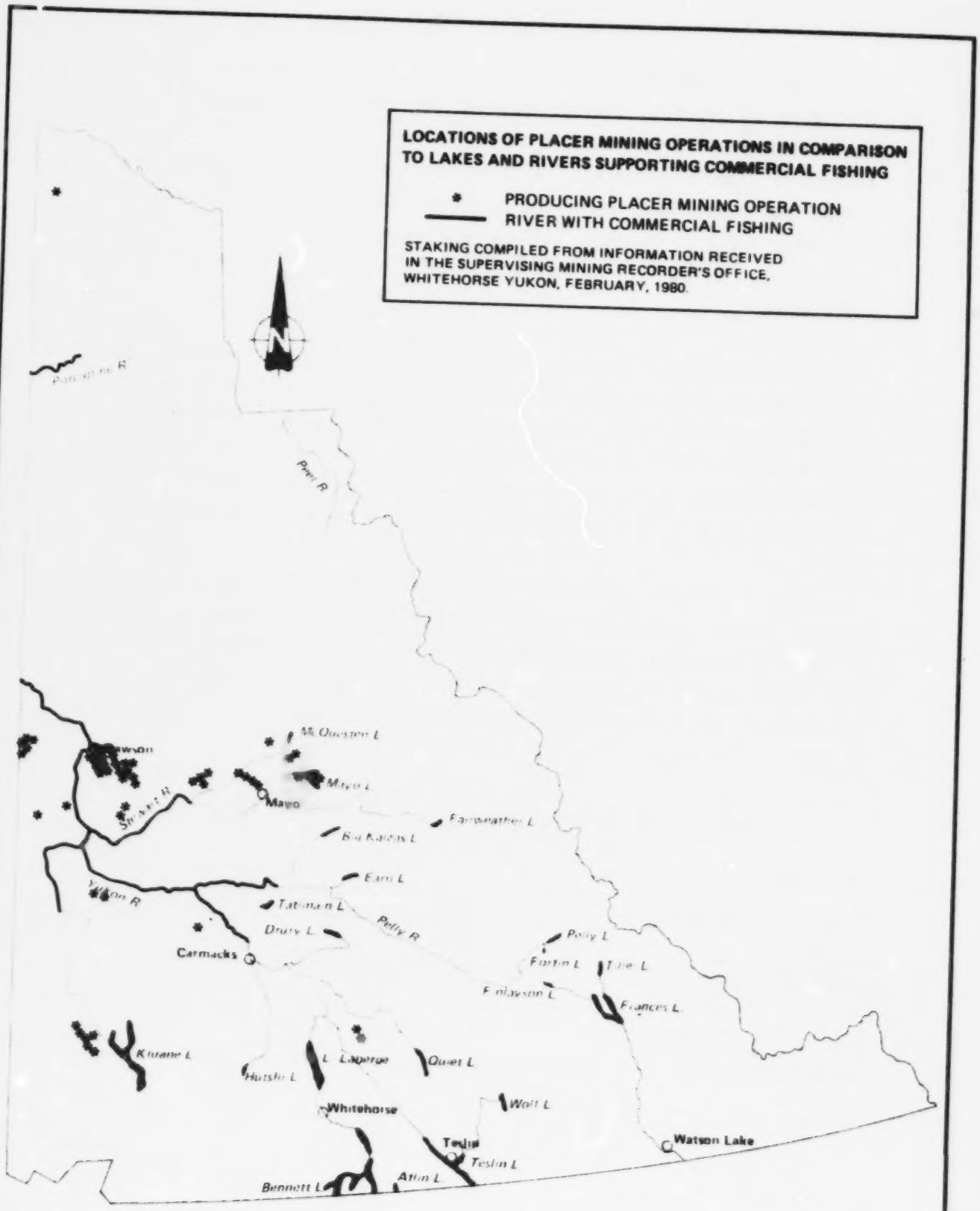
Habitat Rehabilitation Benefits - Commercial Fishery
(millions 1983 $)

Scenario	Discount Rate		
	5%	10%	15%
Status Quo	1.07	0.52	0.35
Optimistic	2.20	1.05	0.71

b) Domestic fishery

The projected increases in salmon and freshwater fish productivity arising from habitat rehabilitation in streams currenty affected by placer mining would also have a direct impact on the domestic fishery. It is expected that the domestic salmon harvest would increase by 10 percent while the harvest of freshwater species would increase by 5 percent. For the status quo scenario, the incremental domestic catch would then be about 50 chinook and 75 chum salmon, and about 200 freshwater fish of mixed species. According to the assumptions for the optimistic development scenario, the domestic harvest would increase by about 250 salmon and 400 freshwater fish as a result of habitat rehabilitation.

It is doubtful that employment in the domestic fishery would be affected by an incremental catch of between 325 and 650 fish. A few



YUKON TERRITORY

SCALE 1:5,000,000

FIGURE 5.2

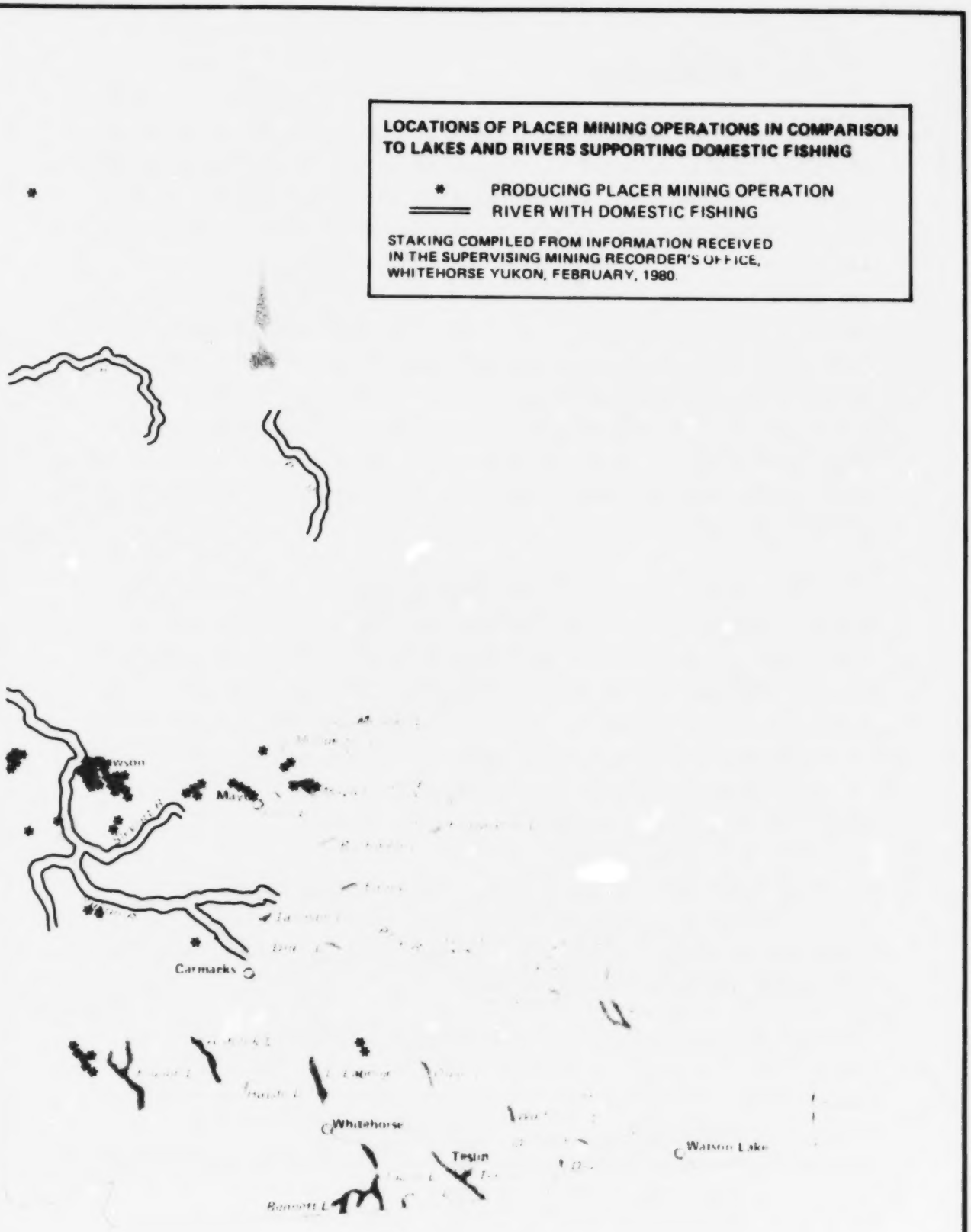
more people may decide to participate in the domestic fishery, but on the basis of observed average catches per domestic fishermen, this would only result in perhaps 3 more licenced fishermen, plus 3 to 6 assistants (family members), participating in the fishery under the status quo scenario. Similarily, under the optimistic scenario, employment in the domestic fishery would involve another 10 to 15 individuals, with 5 as licenced fishermen and the others as assistants.

The individual fishermen to be most affected by the increases in fish productivity are those people fishing for salmon in areas around and downstream from Dawson, and those people fishing for freswater fish species on Mayo Lake and other small lakes in that area. As shown in Figure 5.3, these areas are currently affected by placer mining operations and would be most affected by implementation of the guidelines.

Future benefits to domestic fishermen would also occur. The present value of these additional benefits is shown below, according to the different development scenarios proposed for the domestic fishery. This measure of benefits represents only the additional value of the domestic catch arising from rehabilitation of fish habitat in areas currently affected by placer mining.

Habitat Rehabilitation Benefits - Domestic Fishery
(millions 1983 $)

Scenario	Discount Rate		
	5%	10%	15%
Status Quo	0.47	0.22	0.15
Optimistic	0.94	0.44	0.30


LOCATIONS OF PLACER MINING OPERATIONS IN COMPARISON TO LAKES AND RIVERS SUPPORTING DOMESTIC FISHING
PRODUCING PLACER MINING OPERATION
RIVER WITH DOMESTIC FISHING
STAKING COMPILED FROM INFORMATION RECEIVED IN THE SUPERVISING MINING RECORDER'S OFFICE, WHITEHORSE YUKON, FEBRUARY, 1980.
Dawson
Mayo
Carmacks
Whitehorse
Teslin
Watson Lake

YUKON TERRITORY

SCALE 1:5,000,000

FIGURE 5.3

c) **Native fishery**

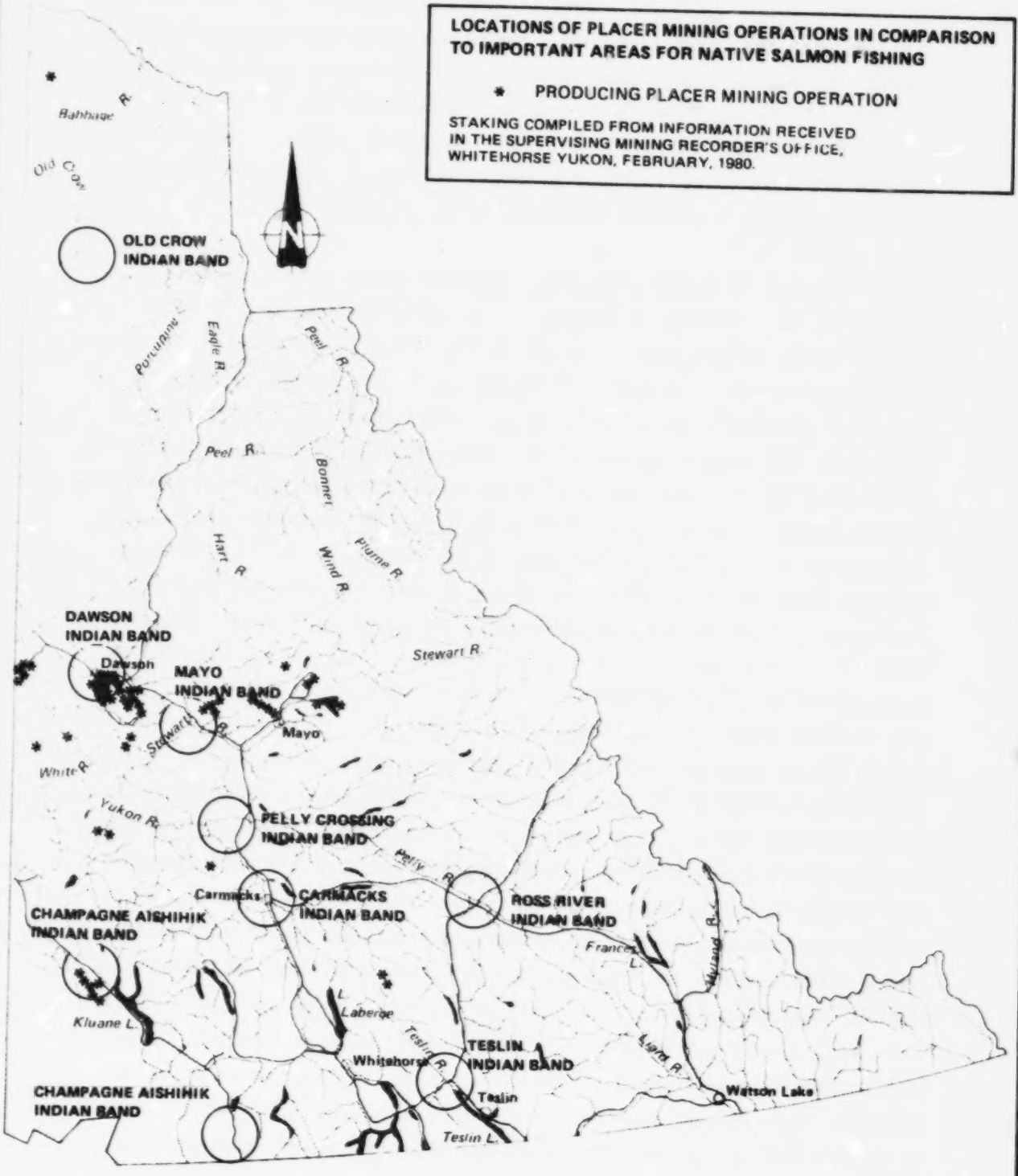
As with the domestic and commercial fisheries, the native catch of salmon is also expected to increase by 10 percent if the proposed placer mining guidelines are implemented. This increase would apply only to chinook and chum salmon in the Yukon River drainage as sockeye and coho salmon are found in areas currently unaffected by placer mining operations (see Figures 2.1 and 3.1). Increased productivity of rehabilitates spawning beds resulting from decreased sediment loads from placer mines would mean about 920 more chinook salmon and 460 chum salmon would be harvested by Yukon Indian people, on the basis of the status quo scenario for the native fishery as described in Section 3.5. Under the optimistic scenario, the native harvest would increase by about 1,800 chinook salmon and 900 chum salmon as a result of rehabilitated spawning areas.

Given the location of salmon habitat currently affected by placer mining activities and areas important for native salmon fishing (see Figure 5.4), it would appear that most of the additional catch would be made by members of the Dawson, Mayo and Champagne-Aishihik Indian bands. Native participation in the fishery would likely rise because of the increased availability of salmon, involving an additional 20 to 30 people under the status quo scenario, and another 40 to 60 people under the optimistic scenario for the native fishery.

Increased salmon productivity in rehabilitated streams would provide a long term increase in native harvests. The present values of these additional future benefits are summarized as follows, using the development scenarios in Section 3.4:

Habitat Rehabilitation Benefits - Native Fishery
(millions 1983 $)

Scenario	Discount Rates		
	5%	10%	15%
Status Quo	1.95	0.93	0.63
Optimistic	3.89	1.86	1.25



YUKON TERRITORY

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FIGURE 5.4

d) Sport fishery

As with the other fisheries, implementation of the proposed water quality guidelines for placer miners would result in greater catches for sport fishermen, due to increased fish populations in areas where placer mining has seriously affected spawning areas. Sport fish catches are assumed to increase by about 10 percent for salmon species and 5 percent for freshwater species.

Although increased catches of fish would undoubtedly improve the quality of sportfishing in Yukon, it is not clear how this change in quality would affect participation in the Yukon sport fishery or its associated values. The number of fish caught is only one of many factors affecting the demand for fishing; studies in other fisheries have found that the secenic beauty of the area and ease of access are often more important factors than catch size in determining angling guality (Canadian Resourcecon, 1982). Paish (1981) notes that even though the total catch of Yukon sport fish appears to have decreased by 28 percent between 1970 and 1975, both the number of anglers and angler effort increased by over 30 percent during the same period. On this basis, then, it is concluded that the increased numbers of fish resulting from implementation of the guidelines would only have a very small impact on the sport fishery. For purposes of this analysis, it is assumed that a 1 percent increase in sport fishing activity would occur, resulting in a 1 percent increase in the consumer surplus benefits experienced by Yukon and Canadian anglers, and a 1 percent increase in visitations and expenditures by non-resident anglers. Using these assumptions, plus the development scenarios outlined in Section 3.4, the present values of the incremental sport fish values attributable to the guidelines can be calculated, and the results of this analysis are presented below:

Habitat Rehabilitation Benefits - Sport Fishery
(millions 1983 $)

Scenario	Discount Rate 5%	10%	15%
Status Quo			
- Consumer Surplus Benefits	0.48	0.21	0.13
- Tourist Expendutures	1.23	0.53	0.34
Optimistic			
- Consumer Surplus Benefits	0.91	0.27	0.16
- Tourist Expeditures	2.34	0.70	0.40

It is expected that this increase in expenditures by non-resident anglers would increase employment in the tourist industry, but this increase would only amount to two jobs per year under the status quo scenario, or 4 jobs per year under the optimistic scenario for the Yukon sport fishery. The increase in consumer surplus benefits would probably be experienced by those anglers fishing for salmon species along the Yukon River and freshwater anglers fishing in lakes adjacent to placer mining operations.

e) **Summary**

In those areas currently affected by placer mining operations it is expected that implentation of the proposed water quality guidelines for the placer mining industry would lead to rehabilitation of spawning areas and the eventual poduction of more fish. The extent of this increased production is estimated to be about 10 percent for salmon species and 5 percent for freshwater species. Increased availability of fish would then affect each of the commercial, domestic, native and sport fisheries by increasing fish harvests by an equivalent percentage. The future fisheries values arising from these increased harvests are summarized in Table 5.1 in terms of discounted present value equivalents. The magnitude of these incremental benefits attributable to rehabilitation of habitat currently affected by placer mining is

TABLE 5.1 SUMMARY OF HABITAT REHABILITATION BENEFITS ATTRIBUTABLE TO PLACER MINING GUIDELINES

(millions 1983 $)

Status Quo Scenario	Discount Rates 5%	10%	15%
Commercial Fishery	1.07	0.52	0.35
Domestic Fishery	0.47	0.22	0.15
Native Fishery	1.95	0.93	0.63
Sport Fishery			
- Consumer Surplus Benefits	0.48	0.21	0.13
- Tourist Expenditures	1.23	0.53	0.34
TOTAL	5.20	2.41	1.60
Optimistic Scenario	**5%**	**10%**	**15%**
Commercial Fishery	2.20	1.05	0.71
Domestic Fishery	0.94	0.44	0.30
Native Fishery	3.89	1.86	1.25
Sport Fishery			
- Consumer Surplus Benefits	0.91	0.27	0.16
- Tourist Expenditures	2.34	0.70	0.40
TOTAL	10.28	4.32	2.82

calculated to range between $2.4 million and $4.3 million (1983 $) depending on the fisheries development scenario under consideration and using a 10 percent discount rate.

Increased fish harvests would also result in increased employment. The extent of these employment benefits in each fishery is identified below, according to the different scenarios used for predicting future levels of activity in each fishery:

	Status Quo Scenario	Optimistic Scenario
Commercial Fishery	8 - 12	26 - 40
Domestic Fishery	3 - 6	5 - 10
Native Fishery	20 - 30	40 - 60
Sport Fishery	2	4
TOTAL	33 - 50	75 - 114

These employment benefits are measured in terms of seasonal jobs attributable to the habitat rehabilitation benefits arising from implementation of the proposed placer mining guidelines.

f) **International benefits**

While the foregoing analysis details the incremental fisheries benefits to Yukon, it must be remembered that a 10 percent increase in salmon productivity would also benefit Alaskan fishermen. In fact, based on the Alaskan and Yukon catches of Yukon River salmon, detailed in Section 3.7, it would appear that Alaskan fishermen would gain substantial benefits from any action leading to greater productivity of Yukon salmon stocks. In fact, the benefits arising from a 10 percent increase in productivity of Yukon salmon stocks would likely result in an additional catch of 20,000 chinook and 53,300 chum salmon by Alaskan fishermen, based on average harvest levels over the last few years. The annual value of this incremental catch would be about $700,000 (using 1981 prices); the discounted present value of future increments in salmon harvests would be about $8.04 million (1983 $) based on a 10 percent discount rate. Thus, Alaskan fishermen would receive about

four times the benefits from increased salmon productivity due to the proposed guidelines that Yukon fishermen would receive from increases in the salmon and freshwater fisheries combined. Clearly, Alaskan fishermen have the most to gain from any improvements in salmon habitat that might occur because of implementation of the proposed water quality guidelines for placer mines.

This distribution of benefits would change, however, if an agreement is reached between the U.S. and Canada regarding the allocation of Yukon River salmon stocks. Such an agreement, as described in Section 3.7, has been reached in principle for Pacific coast salmon fisheries and if the same calculations are applied to the Yukon River fishery, it is possible to estimate how much Canada and Yukon would then stand to gain from a 10 percent increase in Yukon River salmon stocks. These benefits are shown in Table 5.2 using the three different methods for calculating fisheries values described in Section 3.7. Based on this analysis, the combined effects of an allocation agreement and an increase in Yukon salmon productivity would produce additional long term benefits ranging from $1.37 million to to $3.47 million, depending on the method of valuation used and adopting a 10 percent discount rate. Such benefits would effectively double the long term benefits that would result from implementation of the proposed placer mining guidelines. With the allocation agreement, the overall benefits attributable to rehabilitation of spawning areas affected by placer mining would be in the range of $3.78 million to $5.88 million for the status quo scenario and $5.69 million to $7.79 million under the optimistic development scenario for Yukon fisheries resources.

5.3 Habitat Protection Benefits

A second major type of benefit arising from implementation of the water quality guidelines for the placer mining industry is the protection of existing fish habitat in new areas of mining activity. It is likely that, over time, streams not previously worked by placer miners

TABLE 5.2 ADDITIONAL HABITAT REHABILITATION BENEFITS ARISING FROM A U.S. - CANADA FISHERIES TREATY

(millions 1983 $)

Method of Calculation	Discount Rates 5%	10%	15%
Yukon Salmon Prices	2.85	1.37	0.92
Alaska Salmon Prices	4.18	2.01	1.35
Pacific Coast Salmon Prices	7.24	3.47	2.33

will become sites for new placer operations. In the absence of the proposed guidelines, it is expected that these placer operations would cause new habitat disruption through discharges of sediment-laden waste water. With implementation of the guidelines, the allowable discharges of suspended sediments foir these operations would depend on the fish capability of the stream. Compliance with these guidelines would then lead to minimal disruption of fish habitat and productivity.

To assess the magnitude of the habitat protection benefits that may arise from implementation of the guidelines, it is necessary to consider a number of factors. A first consideration is the level of gold production in future years. Two development scenarios for the Yukon placer gold industry were developed in section 2.5, based on expected changes in the price of gold. The high gold price scenario assumes the future price of gold to be $579 (US) at which level some 300 different placer claims would be worked in the absence of the proposed guidelines. This level is considerably higher than the 200 to 250 operations currently in operation. By comparison, the low gold price scenario for the placer mining industry assumes a gold price of only $272 (US) and about 150 active mining operations.

A second factor to consider in determining potential habitat protection benefits is the geographical distribution of placer operations. Currently, most placer mining occurs around Dawson and Mayo, with a small number of operations scattered throughout the rest of Yukon (see Figure 2.1). However, over time it can be expected that other areas having known gold bearing deposits will be developed. As shown in Figure 2.2 known gold bearing streams are located throughout southern Yukon. Consequently, future placer mining operations would be more widely dispersed.

As an increasing number of placer operations start up in these new areas, the potential for damage to fish habitat would grown considerably. Many of the streams having known gold deposits are also spawning grounds for salmon, including sockeye salmon in the Tatshenshini River area. The extent of future habitat damage would

depend largely on the number of new mining operations. Under the high gold price scenario for the mining industry, the potential damages to fish habitat would be quite high. For the low gold price mining development scenario, only half as many placer mines would be operating so that impacts on fish habitat would only be half as great as under the high gold price scenario. To quantify these impacts, it is assumed that the extent of habitat disruption in new mining areas under the optimistic mining development scenario is equal to the amount of habitat currently affected by placer mining. At this level, new placer mining would reduce the production of both salmon and freshwater species by about 5 percent. Under the low gold price scenario for placer mining, a 2.5 percent reduction in fish habitat and productivity is predicted.

Implementation of the proposed placer mining guidelines would affect the extent of new habitat disruption in two ways. First, the additional costs of operating under the new guidelines would cause some operations to cease. As forecast in section 4.2, only 252 operators would remain under the optimistic scenario, while only 126 placer mines would operate under the pessimistic scenario. For these remaining operators, compliance with the water quality guidelines would substantially reduce the discharge of sediments and the associated impacts on spawning and rearing habitat. At the proposed levels of sediment discharge, spawning areas would be largely untouched while sediment concentrations in fish rearing areas would have no noticeable impacts on fish populations. Thus, implementation of the proposed guidelines would effectively eliminate the 5 percent or 2.5 percent reductions in fish habitat and productivity that might otherwise occur if the placer mining industry were to continue to operate under existing water quality guidelines. By protecting fish habitat in this manner, the proposed guidelines would prevent further declines in the Yukon fisheries, and the value of these savings must be determined as a second measure of benefit attributable to the proposed guidelines.

a) **Commercial, domestic and native fisheries**

For the commerical, domestic and native fisheries, the importance of these habitat protection benefits can be calculated directly. On the assumption that an additional 5 percent loss of fisheries habitat would result in an equal reduction of fish populations, future development of the placer mining industry under high gold prices would cause a 5 percent decline in each of the commercial, domestic and native harvests. Using the same assumptions, development of the placer mining industry under the pessimistic scenario would result in a 5.3 percent decline in each fishery. The measure of habitat protection benefits is then based on the value of the catch that would otherwise be lost due to declining fish populations. Estimates of these habitat protection benefits for each fishery are presented in Tables 6.4 and 5.4, according to the different scenarios for both the placer mining industry and fisheries; these estimates represent the discounted present values of future habitat protection benefits.

b) **Sport fishery**

For the Yukon sport fishery a slightly different method for determining habitat protection benefits must be used, because the demand for angling is only partially determined by catch success rates. Consequently, it is assumed that a 5 percent reduction in fish populations would lead to only a 1 percent decline in fishing activities and values. Similarly, a 2.5 reduction in fish harvests is assumed to cause a 0.5 percent drop in angler activity and values. These assumptions are consistent with the methodology employed in section 5.2 to determine the extent of sport fish benefits attributable to rehabilitation of disturbed spawning areas. The habitat protection benefits for the sport fishery, as calculated by using the assumptions noted above, are also shown in Tables 5.3 and 5.4.

TABLE 5.3 SUMMARY OF HABITAT PROTECTION BENEFITS ATTRIBUTABLE TO PLACER MINING GUIDELINES, HIGH GOLD PRICE SCENARIO

(millions 1983 $)

Fisheries: Status Quo Scenario	Discount Rates 5%	10%	15%
Commercial Fishery	0.51	0.24	0.16
Domestic Fishery	0.23	0.11	0.07
Native Fishery	0.88	0.42	0.28
Sport Fishery			
- Consumer Surplus Benefits	0.48	0.20	0.13
- Tourist Expenditures	1.23	0.52	0.34
TOTAL	3.33	1.49	0.98
Fisheries: Optimistic Scenario	**5%**	**10%**	**15%**
Commercial Fishery	1.05	0.50	0.34
Domestic Fishery	0.46	0.22	0.15
Native Fishery	1.75	0.84	0.56
Sport Fishery			
- Consumer Surplus Benefits	0.90	0.27	0.15
- Tourist Expenditures	2.31	0.69	0.40
TOTAL	6.47	2.52	1.60

TABLE 5.4 SUMMARY OF HABITAT PROTECTION BENEFITS ATTRIBUTABLE TO PLACER MINING GUIDELINES, LOW GOLD PRICE SCENARIO

(millions 1983 $)

Fisheries: Status Quo Scenario	Discount Rates 5%	10%	15%
Commercial Fishery	0.26	0.12	0.08
Domestic Fishery	0.11	0.06	0.04
Native Fishery	0.44	0.21	0.14
Sport Fishery			
- Consumer Surplus Benefits	0.28	0.10	0.07
- Tourist Expenditures	0.62	0.26	0.17
TOTAL	1.67	0.75	0.50
Fisheries: Optimistic Scenario	**5%**	**10%**	**15%**
Commercial Fishery	0.52	0.25	0.17
Domestic Fishery	0.23	0.11	0.07
Native Fishery	0.88	0.42	0.28
Sport Fishery			
- Consumer Surplus Benefits	0.45	0.13	0.08
- Tourist Expenditures	1.16	0.35	0.20
TOTAL	3.24	1.26	0.80

c) Employment

Without the proposed placer mining guidelines, future losses of fish habitat and subsequent declines in harvests (as described above) would also affect employment in each fishery. Fewer fish would mean less participation in the Yukon fisheries and fewer employment benefits. Implementation of the guidelines to protect fish habitat would consequently provide employment protection benefits. The extent of these benefits are shown in Table 5.5 and are described below.

For purposes of this analysis it is assumed that a 5 percent decline in harvest for the commercial, domestic or native fishery would produce a corresponding decline in seasonal employment benefits for each fishery. Given the indirect linkage between the size of the sport catch and employment levels in the Yukon tourist industry, it is assumed that a 5 percent decline in catch would result in a 1 percent decline in both tourist expenditures and employment in the tourist sector. These assumptions enable calculation of the employment benefits attributable to the placer mining guidelines under the high gold price scenario for the placer mining industry. For the low gold price scenario similar assumptions are utilized: a 2.5 percent decline in employment in each of the commercial, domestic and native fisheries and a 0.5 percent decline in employment in the tourist industry would be expected without implementation of the placer mining guidelines. With these assumptions, and considering the future levels of seasonal employment in the Yukon fishery under the two fisheries development scenarios, implementation of the guidelines is estimated to protect between 12 and 58 seasonal jobs, depending upon the combination of fisheries and gold price scenario.

d) Summary

In present value terms, the fish habitat protection benefits resulting from implementation of the placer mining guidelines would amount to between $0.75 million and $2.52 million, according to the various development scenarios for both the placer mining industry and

TABLE 5.5 EMPLOYMENT BENEFITS ATTRIBUTABLE TO HABITAT PROTECTION BENEFITS ARISING FROM PLACER MINING GUIDELINES

(number of jobs)

Fisheries: Status Quo Scenario	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
Commercial Fishery	3 - 5	6 - 9
Domestic Fishery	3 - 5	6 - 9
Native Fishery	5	11
Sport Fishery	1	2
TOTAL	12 - 16	25 - 31
Fisheries: Optimistic Scenario		
Commercial Fishery	6 - 9	13 - 20
Domestic Fishery	4 - 6	8 - 12
Native Fishery	11	22
Sport Fishery	2	4
TOTAL	23 - 28	47 - 58

Yukon fisheries, and using a 10 percent discount rate. These amounts represent losses that would otherwise occur if the placer mining guidelines are not implemented. Similarly, between 12 and 58 seasonal jobs in the Yukon fishery would be perserved by implementation of the proposed guidelines.

e) International benefits

Without implementation of the proposed guidelines, future development of the Yukon placer mining industry would have a significant impact on Alaskan fisherman. For example, under the high gold price scenario for the placer mining industry, the resulting loss of habitat would cause a 5 percent decline in Alaskan catches of Yukon River salmon worth about $296,000 annually, or $3.2 million in discounted present value terms (1983 $, 10 percent discount rate). Similarly, a 2.5 percent reduction in Alaskan salmon harvests would occur under the low gold price scenario for Yukon placer mining; this loss would be worth about $1.6 million over the long term. If the proposed placer mining guidelines are implemented, and salmon habitat in Yukon is not further disrupted by future placer mining activities, these losses would not occur. Given the relative magnitude of these habitat protection benefits ($1.6 - $3.2 million), it is clear that Alaskan fishermen would benefit more from implementation of the proposed guidelines than would Yukon fishermen.

Part of these habitat protection benefits would be retained by Canadian fishermen, however, if an allocation formula for sharing Yukon River salmon between Canada and the U.S. can be agreed upon. Using the allocation methodology proposed for Pacific salmon runs, the extent of these additional habitat protection benefits to Canadian fishermen is shown in Table 5.6 for both the optimistic and pessimistic placer mining industry development scenarios. Depending on the method used to calculate the value of the salmon catch, these additional habitat protection benefits would range from $0.31 million to $1.56 million (assumes a 10 percent discount rate).

TABLE 5.6 ADDITIONAL HABITAT PROTECTION BENEFITS ARISING FROM A U.S. - CANADA FISHERIES TREATY

(millions 1983 $)

High Gold Price Scenario

Method of Calculation	Discount Rates 5%	10%	15%
Yukon Salmon Prices	1.28	0.62	0.41
Alaska Salmon Prices	1.88	0.90	0.61
Pacific Coast Salmon Prices	3.26	1.56	1.05

Low Gold Price Scenario

Method of Calculation	5%	10%	15%
Yukon Salmon Prices	0.64	0.31	0.21
Alaska Salmon Prices	0.94	0.45	0.30
Pacific Coast Salmon Prices	1.63	0.78	0.53

CHAPTER 6

BENEFIT-COST SUMMARY OF THE PROPOSED GUIDELINES

To this point in the analysis, a general description of the proposed guidelines for the Yukon placer mining industry has been presented along with an assessment of how implementation of these guidelines would affect both the placer mining industry and Yukon fisheries. The general conclusions from this exercise indicates that while the guidelines would result in higher costs for the placer mining industry, the Yukon fisheries would benefit from the resulting improvements in water quality and fish productivity. To assess the desirability of the proposed guidelines, it is then necessary to consider and compare the various costs and benefits that are predicted to occur if the guidelines are indeed implemented.

In considering the results of the benefit-cost comparison in Table 6.5, it must be remembered that this report has been prepared primarily as an information document and is not intended to draw any conclusions about the desirability of implementing the proposed guidelines. The results of this assessment are based on the best available information and reasonably portray the relative economic significance of the gold placer mining industry and the fishing industry. However the shortage of data caused some methodological problems. The most important of these is that gross values were used to measure the economic importance of both the placer mining and fisheries industries. These gross values considered only the total revenues and user benefits attributable to each industry with no consideration of the costs incurred by the participants in this industry. Consequently the gross values do not measure the actual net contribution to the Yukon economy of each industry. Had the analysis been done using net values (gross values minus costs) a much better assessment of the economic importance of each industry could have been made. Unfortunately, since information on the costs of placer mining and fishing activities does not exist, the analysis was limited to an examination of gross values. The benefit-cost ratio presented in section 6.1 may be somewhat different if a net value comparison were to be made.

This benefit-cost comparison of the proposed guidelines has been undertaken using two different methods of analysis. The first

method examines quantitative changes in the Yukon economy by contrasting the declining revenues from placer mining with the increasing revenues and user benefits in the various Yukon fisheries. Such changes are termed "allocative impacts" and are considered in the remainder of this chapter. The second type of analysis examines qualitative changes in the Yukon economy, including impacts on employment and any changes in the distribution of resources among peoples or regions. These changes are termed "non-allocative impacts" and are the subject of section 6.2.

6.1 Allocative impacts

a) Impacts on placer mining industry

Tables 6.1 and 6.2 summarize the findings and assessments of the major impacts of the proposed guidelines on the placer mining industry. They are namely:

- Decrease in gold production;
- Increase in cost of settling ponds;
- Increase in cost of diversions built to engineered specifications when required;
- Increase in cost of rehabilitation of the mined areas;
- Increase in cost of recontouring the tailings.

b) Impact on Yukon fisheries

Based on the analysis in Chapter 5, the Yukon fisheries would benefit from implementation of the proposed placer mining guidelines in two different ways. First, the guidelines would require existing operators to decrease the extent of their sediment discharges into streams thereby enabling rehabilitation of fish spawning and rearing habitat in presently disturbed areas. This habitat rehabilitation would eventually lead to increases in both anadromous and freshwater fish populations, resulting in increased catches for each of the commercial, domestic, native and sport fisheries. The second type of fisheries benefits attributable to the guidelines is habitat protection. Without the guidelines it is likely that the future development of the placer mining industry would result in further destruction of fish habitat, causing declines in fish populations and fish harvests. As implementation of the guidelines would protect this fish habitat, no declines in fish harvests would result thereby representing a form of benefit or savings to the Yukon fisheries.

To calculate the extent of these habitat rehabilitation and protection benefits, a number of different scenarios have been developed. For the fisheries industry, a status quo scenario based on

TABLE 6.1 SUMMARY OF IMPACTS ON PLACER MINING INDUSTRY, LOW GOLD PRICE SCENARIO

(millions 1983 $)

IMPACTS	DISCOUNT RATE 5 %	10 %	15 %
Decrease in gold production	$ 19.7	$ 15.6	$ 12.8
Settling ponds	2.0- 6.3	1.6- 5.0	1.3-4.1
Diversion	0.2- 0.9	0.2- 0.7	0.2-0.6
Rehabilitation	2.5- 3.7	2.0- 3.0	1.6-2.5
Recontouring	7.9-14.8	6.3-11.7	5.1-9.6
TOTAL	32.3-45.4	25.7-36.0	21.0-29.6

TABLE 6.2 SUMMARY OF IMPACTS ON PLACER MINING INDUSTRY, HIGH GOLD PRICE SCENARIO

(millions 1983 $)

IMPACTS	DISCOUNT RATE 5 %	10 %	15 %
Decrease in gold production	$ 118.4	93.8	77.0
Settling ponds	3.9-12.8	3.1-10.2	2.6- 8.3
Diversion	0.4- 1.8	0.4- 1.4	0.3- 1.2
Rehabilitation	5.0- 7.4	4.0- 5.7	3.2- 4.8
Recontouring	15.8-32.6	12.5-23.4	10.3-19.3
TOTAL	143.5-173.0	113.8-134.5	93.4-110.6

continuation of current levels of harvesting activities is considered most likely while an optimistic scenario has been proposed on the basis of larger catches of salmon. The habitat rehabilitation and protection benefits for these scenarios are presented in Tables 6.3 and 6.4, for each of the proposed development scenarios for the placer mining industry. It is noteworthy that the fisheries benefits from habitat rehabilitation are greater than the benefits from habitat protection.

c) Benefits - costs comparison

A comparison between Tables 6.1 - 6.2 and Tables 6.3 - 6.4 indicates that the incremental costs for the placer mining industry resulting from implementation of the proposed guidelines exceed the corresponding incremental benefits by a factor of at least 5. This is illustrated in Table 6.5.

One way to make comparison between benefits and costs is to calculate a benefit/cost ratio (B/C). In this case the B/C would be between 0.03 and 0.19 (at 10 percent discount rate) which means that for each dollar of incremental benefits there will be between $5 and $33 of incremental costs.

The B/C ratio is calculated by dividing the total benefits by the total costs:

Low Gold Price Scenario: Price of Gold $412.50

$$\text{B/C ratio } \frac{3.90}{123} = 0.03$$

High Gold Price Scenario: Price of Gold $875.00

$$\text{B/C ratio } \frac{5.58}{30} = 0.19$$

(at 10 percent discount rate)

Table 6.3 **SUMMARY OF FISHERIES BENEFITS ATTRIBUTABLE TO PROPOSED PLACER MINING GUIDELINES**

LOW GOLD PRICE
(millions 1983 $)

FISHERIES: STATUS QUO SCENARIO	DISCOUNT RATES 5%	10%	15%
Habitat Rehabilitation Benefits	$ 5.20	$ 2.41	$ 1.60
Habitat Protection Benefits	1.67	0.75	0.50
TOTAL	$ 6.87	$ 3.16	$ 2.10

FISHERIES: OPTIMISTIC SCENARIO	DISCOUNT RATES 5%	10%	15%
Habitat Rehabilitation Benefits	$ 10.28	$ 4.32	$ 2.82
Habitat Protection Benefits	3.24	1.26	0.80
TOTAL	$ 13.52	$ 5.58	$ 3.62

Table 6.4 **SUMMARY OF FISHERIES BENEFITS ATTRIBUTABLE TO PROPOSED PLACER MINING GUIDELINES**

HIGH GOLD PRICE
(millions 1983 $)

FISHERIES: STATUS QUO SCENARIO	DISCOUNT RATES 5%	10%	15%
Habitat Rehabilitation Benefits	$ 5.20	$ 2.41	$ 1.60
Habitat Protection Benefits	3.33	1.49	0.98
TOTAL	$ 8.53	$ 3.90	$ 2.58

FISHERIES: OPTIMISTIC SCENARIO	DISCOUNT RATES 5%	10%	15%
Habitat Rehabilitation Benefits	$10.28	$ 4.32	$ 2.82
Habitat Protection Benefits	6.47	2.52	1.60
TOTAL	$16.75	$ 6.84	$ 4.42

Table 6.5 BENEFIT-COST SUMMARY OF THE PROPOSED GUIDELINES - (million 1983 $)

FISHERIES SCENARIO		LOW GOLD PRICE SCENARIO DISCOUNT RATE 5%	10%	15%	HIGH GOLD PRICE SCENARIO DISCOUNT RATE 5%	10%	15%
Status Quo	Fisheries Benefits	6.87	3.16	2.10	8.53	3.90	2.58
	Costs to Mining	37	30	25	155	123	100
	B/C Ratio	0.19	0.11	0.08	0.06	0.03	0.03
Optimistic	Fisheries Benefits	13.52	5.58	3.62	16.75	6.84	4.42
	Costs to Mining	37	30	25	155	123	100
	B/C Ratio	0.37	0.19	0.14	0.11	0.06	0.04

These ratios are contingent on the use of gross values and may vary if data on net values becomes available.

6.2 Non-allocative impacts of the proposed guidelines

As required in the guidelines for the preparations of SEIA's, it is necessary to examine the impacts of the proposed placer mining guidelines on such things as employment, inflation, regional economies, balance of payments and other factors related to the structure of an economy These non-allocative impacts are considered below for both the placer mining industry and the Yukon fisheries.

a) Placer mining industry

For the placer mining industry the most signifant forms of non-allocative impacts arising from implementation of the proposed placer mining guidelines would appear to be reductions in employment and reduced spending by the mining industry on local goods and services. As derived in section 4, these impacts are summarized in Tables 6.6 and 6.7. These impacts are considered to be significant given that the Yukon economy is currently facing high unemployment and a declining industrial base with limited possibilities for economic recovery in the short term.

b) Yukon fisheries

Implementation of the proposed placer mining guidelines would result in two types of distributional impacts on Yukon fisheries. In terms of impacts on employment, some 45 to 170 seasonal jobs in the fishery would either be created or saved depending on the choice of development scenarios for both the placer mining and fisheries industries. Most of these employment benefits would arise from habitat rehabilitation, with increased fish populations attracting more fishermen. Similarly, protection of habitat would prevent any future declines in the fisheries, so that a number of seasonal jobs would be saved. A complete summary of these employment benefits is presented as Table 6.8.

Table 6.6 PRESENT VALUE OF THE SECONDARY IMPACT OF THE DECREASE IN GOLD PRODUCTION, 1983-1995
(millions 1983 $)

SECONDARY IMPACTS	DISCOUNT RATES 5%	10%	15%
Low gold price scenario	7.9	6.3	5.1
High gold price scenario	47.8	37.5	30.8

Table 6.7 DECREASE IN EMPLOYMENT IN THE PLACER MINING INDUSTRY
(annual man years)

EMPLOYMENT IMPACTS	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
Diect employment	20-24	48-56
Indirect employment	10-12	24-28
TOTAL EMPLOYMENT	30-36	72-84

Table 6.8 SUMMARY OF FISHERIES EMPLOYMENT BENEFITS ATTRIBUTABLE TO PROPOSED PLACER MINING GUIDELINES
(numbers of jobs)

FISHERIES: STATUS QUO SCENARIO	LOW GOLD PRICE SCENARIO	HIGH GOLD PRICE SCENARIO
Employment Benefits From Habitat Rehabilitation	33 - 50	33 - 50
Employment Beneftis From Habitat Protection	12 - 16	25 - 31
TOTAL	45 - 66	58 - 81
FISHERIES: OPTIMISTIC SCENARIO		
Employment Benefits From Habitat Rehabilitation	75 - 114	75 - 114
Employment Benefits From Habitat Protection	23 - 28	47 - 58
TOTAL	98 - 142	122 - 172

The second type of distributional impact of the guidelines relates to the consequences of a Canada - U.S. treaty on Yukon River basin salmon. Were such a treaty signed soon, and if the formula for determining the Canadian component of the harvest is similar to the formula to be employed for Pacific Salmon, the potential fisheries benefits attributable to the guidelines would be as shown in Table 6.9. If the extra harvest were to be taken by Yukon fishermen, the value of the fishery would increase by between $1.7 and $2.0 million (assuming 10 percent discount rate). Alternately, if the Alaskans were to pay compensation for the increment in catch, the economic benefits would range between $2.5 and $2.9 million although many of these benefits might be added to the Canadian rather than Yukon economy. As a third alternative, if the incremental catch were taken from the Pacific coast fishery the benefits to the Canadian economy would range from $4.3 to $5.0 million while the Yukon economy might not benefit at all.

Table 6.9 SUMMARY OF FISHERIES BENEFITS FROM A U.S. - CANADA FISHERIES TREATY ATTRIBUTABLE TO PLACER MINING GUIDELINES

LOW GOLD PRICE SCENARIO
(millions 1983 $)

METHOD OF CALCULATION	DISCOUNT RATES 5%	10%	15%
Yukon Salmon Prices	$ 3.49	$ 1.68	$ 1.13
Alaska Salmon Prices	$ 5.12	$ 2.46	$ 1.65
Pacific Coast Salmon Prices	$ 8.87	$ 4.25	$ 2.86

HIGH GOLD PRICE SCENARIO
(million 1983 $)

METHOD OF CALCULATION	DISCOUNT RATES 5%	10%	15%
Yukon Salmon Prices	$ 4.13	$ 1.99	$ 1.33
Alaska Salmon Prices	$ 6.06	$ 2.91	$ 1.96
Pacific Coast Salmon Prices	$10.50	$ 5.03	$ 3.38

Appendix I

SITE SPECIFIC MINING PRACTICES

APPENDIX I SUMMARY OF SITE SPECIFIC MINING PRACTICES

REACH CLASSI-FICATION	Water ACQUISITION	ULTIMATE SUSPENDED SOLIDS EFFLUENT STANDARD	DIVERSIONS	LEAVE STRIPS
A	1) Taken by pumping only. 2) Screening required.	1) 0 mg/l suspended solids. 2) No toxic discharge.	Not permitted.	1) 30 m wide on both sides of stream. 2) A berm may be required.
B	1) Taken by pumping only. 2) Screening required.	1) 100 mg/l suspended solids. 2) No toxic discharge.	Not permitted.	1) 15 m wide on both sides of stream. 2) A berm may be required.
C	Screening required if fish present.	1) 100 mg/l suspended solids. 2) No toxic discharge.	1) Must contain one in ten year flood. 2) Provision of fish passage. 3) Opened during spring freshet.	One bank to remain vegetated.
D	Screening required if fish present.	1) 100 mg/l if to A, B, C or D. 2) 1000 mg/l suspended solids if flowing into major D. 3) No toxic discharge.	1) Must contain one in five year flood. 2) Fish passage if A, B or C upstream.	Not required.
X	Screening required if fish present.	1) 100 mg/l if to A, B, C or D. 2) 1000 mg/l suspended solids if flowing into major D. 3) No toxic discharge.	1) Must contain one in five year flood.	Not required.

Appendix II

COMPLIANCE SCHEDULE

APPENDIX II REACH CLASSIFICATION AND RESULTANT COMPLIANCE DATES ILLUSTRATING THE REQUIRED SUSPENDED SOLIDS CRITERIA

REACH CLASSIFICATION	1984	1985	1986	1987	1988
A	100	0	0	0	0
B	100	100	100	100	100
C	1,000	500	300	300	100
D to Major D	1,000	1,000	1,000	1,000	1,000
D to A, B, C	1,000	500	300	300	100
X to Major D	1,000	1,000	1,000	1,000	1,000
X to A, B, C	1,000	500	300	300	100

Appendix III

CURRENT GUIDELINES FOR THE YUKON PLACER MINING INDUSTRY

(1976 Guidelines)

APPENDIX III

PLACER MINING OPERATING GUIDELINES IN REGARD TO WATER USE AUTHORIZATIONS

The Yukon Territory Water Board has directed that the Controller of Water Rights may issue Authorizations to Use Water Without a Licence for placer mining operations under Section 11(b) of the Northern Inland Waters Regulations (the proposed use will continue for a period of less than 270 days). The Board adopts the following criteria as guidelines for the issuing of authorizations:

1. All operations are to provide, where practicable, effective settling facilities to the satisfaction of the Controller.

2. In streams or parts thereof which are determined to be critical for sustaining fish stocks or for the protection of other water users, it may be mandatory to provide the following:
   a) fish passage facilities.
   b) uninterrupted minimum discharges.
   c) effective settling facilities.
   d) screens on water intakes in which the stripping methods of ground sluicing, monitoring, and the use of automatic gates is practised.

   The Controller will maintain a list of creeks that are not considered critical for sustaining fish stocks or critical for the protection of other water users. This list will be subject to review from time to time in consultation with the Fisheries Service.

3. Stabilization of the tailings and stripped areas to prevent a detrimental impact on the stream may be required.

4. Where the Water Board deems it necessary, an applicant will be required to provide an environmental impact statement or any other relevant information.

5. A Water Use Licence, rather than an authorization, will be required by a placer mining operation where the Board is satisfied that it will be in the public interest.

An appeal may be filed with the Board within ten days from any written notice, direction or order given by the Controller in applying these guidelines.

Appendix IV

GOLD PRODUCTION FORECAST MODEL

APPENDIX IV

FORECAST MODEL

Table 2.13 shows the gold production and the price of gold (expressed in 1981 US $).

A linear regression is used[a] to establish a mathematical relation between the price of gold and the production of gold. Two alternatives are considered.

First, the annual production can be explained by the price of gold for that year, expressed in 1981 US dollars. This means that, for say 1976, production is related to the price of gold in 1976. Under this hypothesis, the linear regression gives us these results:

---

a Linear regression is a technique used for forecasting using observations made in the past. Graph 2.4 shows a cloud of points associating price and gold production from Table 2.13. Then we want to find a mathematical relation that will relate the behaviour of those two variables. In this case variable x will be the price of gold (in 1981 US $) and variable y the associated gold production.

Thus, if we can find a satisfying linear relationship between the variables we will be able to make some forecast of production under scenarios of gold prices. Then the best linear relationship will be the one which minimized the square of distances of each point to the line and the relationship is express in the y=ax+b form.

The R^2 is the correlation factor between the two variables; its range is from +1 to 0. R^2 close to 1 indicates a strong correlation between them while an R^2 near 0 means that there is little or no correlation between those two variables.

$R^2 = 0.81$

$y = -17,639 + 158x$

Second, the production of one year and number of operators can be explained by the price of gold in the preceding year. This means that, for say 1976, production is related to the 1975 price of gold. Under this hypothesis, the linear regression gives us these results:

$R^2 = 0.92$

$y = -18,392 + 180x$

The correlation factor (R^2) of those two regression lines is quite high and it allows us to use them for forecasting. Since the R^2 of the second equation is higher we will use it for further analysis. This linear regression is illustrated in Graph IV-I.

Thus, the fluctuation in the production of gold can be explained by the variation in the price of gold in the preceding year. To forecast gold production we will use the following equation:

$y = -18,392 + 180x$

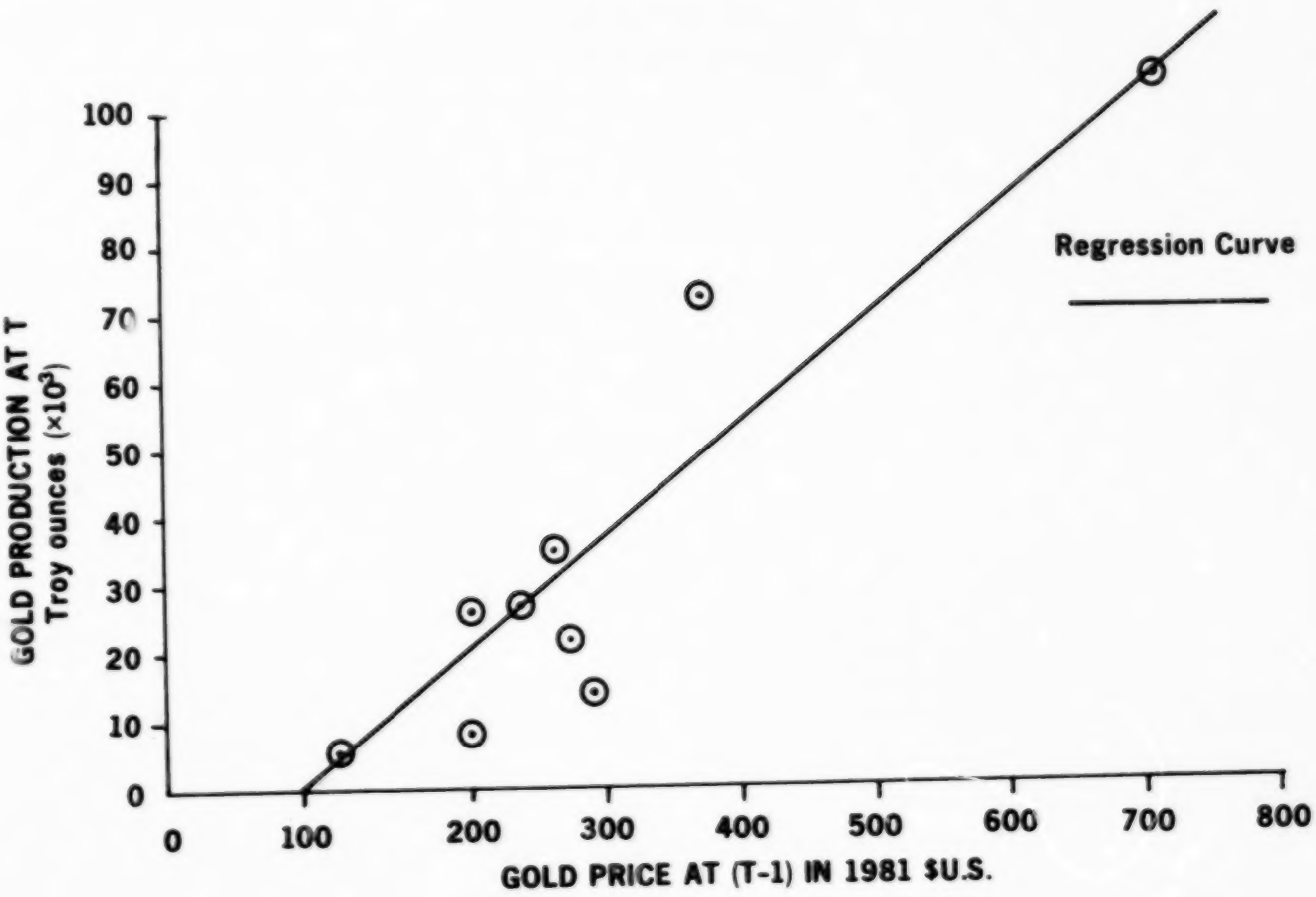
Where y = placer gold production in troy ounces

x = the price of gold in 1981 US $.

APPENDIX IV TABLE 1 PRICE AND PRODUCTION OF GOLD

YEAR	PRICE 1981 US $	PRODUCTION TROY OUNCES
1972	109	5,493
1973	205	5,293
1974	285	8,509
1975	270	12,136
1976	199	21,312
1977	222	25,692
1978	269	25,780
1979	384	35,076
1980	675	73,026
1981	460	99,800

APPENDIX IV GRAPH 1 REGRESSION CURVE



Appendix V

MULTIPLIER FOR THE PLACER MINING INDUSTRY

APPENDIX V

MULTIPLIER FOR THE PLACER MINING INDUSTRY

Several multipliers have been cited for the mining industry in general and placer mining in particular.

The ERPB of the Government of Yukon has developed the following multipliers:

APPENDIX V TABLE 1 MULTIPLIERS

	HARDROCK MINING	PLACER MINING
Employment	2.5	1.5
Value added	2.3	N/A
Wages/salaries	2.1	1.2

The Centre for Resource Studies of Queen's University has identified the following multipliers for the Canadian mining industry:

Output	1.5 to 2.0
Wages/salaries	2.0
Employment	2.0 to 3.0

For the purpose of this report the multipliers for placer mining developed by ERPB will be used. It will be assumed that the value added multiplier for placer mining is 1.4. This has been estimated by applying the factor .6 to the value added multiplier for hardrock mining (.6 x 2.3 = 1.4). The factor .6 is the ratio of the employment and the wages/salaries multipliers for placer mining to the same multipliers for hardrock mining.

Appendix VI

RISK MODEL FOR THE PLACER MINING INDUSTRY

APPENDIX VI

RISK MODEL FOR THE PLACER MINING INDUSTRY

A risk model can be developed by identifying, for a specific industry, what are the risk factors associated with that industry and by assigning a weight to each of these factors.

Then for each situation it is possible to estimate the related weight and thus it is possible to make a comparison between situations and estimate what situation shows the higher level of risk.

This model will be used in order to estimate how many operators will face such a high level of difficulty, that they may have little choice but go out of business or be relocated, leaving behind a valley that otherwise would have been mined.

This forecast will be done by estimating the impact of the proposed guidelines on present operations, which can be viewed as a sample of future operations because from observation, there is no great differences in terrain between unworked creeks and presently worked creeks.

To build the risk model four (4) factors have been considered, they are: the stream classification, the size of operation, the time in business, and the valley width.

Stream Classification:

The stringency of the conditions set by the proposed guidelines vary with the stream classifications. (See Appendices I and II)

We can identify five levels of stringency concerning mainly the effluent standards and also other mining practices. They are A, B, C, D, d. D is used for D or X streams which flow into A, B, C streams and d is used for D or X streams that flow into a major D stream.

We assume that the more stringent the operating conditions associated with the class, the higher will be the risk for operators.

Size of Operations:

The larger operations may have more resources available (men, equipment and financial backing) to build settling pond, diversion, etc. in order to meet the guidelines.

Years in Business:

What was determined is which of the present operators were active on their claims during or before the 1979 season. Because it usually takes 3 years to start recovering the investment, and because people starting in 1979 didn't expect the 1980's gold rush so they weren't attracted by the high gold value.

So, it is assumed that anyone active in 1979 and still active in 1982 on the same property must have proven ground and, therefore, probably is more capable of complying with the guidelines. Those operators might have superior skill and knowledge about placer mining and construction techniques compared to newcomers and therefore their ability to meet guidelines is higher.

Moreover, those who have been active the longest might have more room for settling facilities and for storing overburden.

Valley Width:

The width of the valley has generally been recognized as a serious limiting factor on the ability of operators to meet the proposed guidelines. Quite simply, the narrower the valley the less area the operator has to construct settling ponds and diversions, to operate around leave strips (if required), to store overburden and generally to mine the property.

(a) A score system

From the above four factors, the level of creek classification (in particular the effluent standard) and the valley width have been assumed to be prime determinants of ability to comply, so they have been weighted accordingly; 70% of the weight has been assigned to these factors while the remaining 30% will be assigned to size of operation and time in business factors.

As stated previously, the stream classification have a five levels stringency, the associated weights are the following:

Classification	Weight
A	35
B	30
C	20
D	15
d	10

The size of operation has been divided into three classes:

Size of Operation	Symbol	Weight
1-2 employees (small)	S	15
3-5 employees (medium)	M	10
6 + employees (large)	L	5

The "year in business" factor has been divided into two classes:

Time in Business	Symbol	Weight
Non-active during and before 1979	T	15
Active during and before 1979	B	5

The valley width is also divided in two categories; the narrow valley and the wide valley. The separation line between the two has been fixed at 350 m. The choice of 350 m comes from a Hardy & Associate study (Guidelines for Reclamation of Placer Mining Operations, Klondike Region, Report for Yukon Territorial Water Board, 1979).

Their study shows: "...valleys which can be placer mined without disturbing the stream and those which are too narrow to permit this economically...", "the environmental impact on the narrow valleys is total i.e. in order to mine these valleys economically, the stream must be totally disrupted." (Above reference p. A-1.)

Valley Width	Symbol	Weight
Narrow	N	35
Wide	W	10

Under the score system a 100 points will be assigned to the ASTN (most difficult) possibility and the minimum score of 30 points will be assigned to the dLBW (least difficulty) possibility.

(b) The breakdown

A review of DFO maps of creek classification and personal communication with the DIAND staff (Jack Nickel, Ruth Debicki and George Gilbert) shows the following distribution:

Factor		% of Operators
Stream classification	A	2.2%
	B	3.6%
	C	15.2%
	D	29.0%
	d	50.0%
		100%
Size of operation	S	52.0%
	M	32.0%
	L	16.0%
		100%
Factor		**% of Operators**
Time in business	T	54%
	B	46%
		100%
Valley width	N	50%
	W	50%
		100%

(c) **The model**

By combining all the different parameters we can associate a score and a percent of operations to each of the following combinations:

APPENDIX VI TABLE 1 RISK MODEL

COMBINATION	% OF OPERATION	SCORE	COMBINATION	% OF OPERATION	SCORE
ASTN	0.31	100	CMBN	1.12	70
ASTW	0.31	75	CMBW	1.12	45
ASBN	0.26	90	CLTN	0.66	75
ASBW	0.26	65	CLTW	0.66	50
AMTN	0.20	95	CLBN	0.56	65
AMTW	0.20	70	CLBW	0.56	40
AMBN	0.16	85			
AMBW	0.16	60	DSTN	4.08	80
ALTN	0.10	90	DSTW	4.08	55
ALTW	0.10	65	DSBN	3.46	70
ALBN	0.08	80	DSBW	3.46	45
ALBW	0.08	55	DMTN	2.50	75
			DMTW	2.50	50
BSTN	0.51	95	DMBN	2.14	65
BSTW	0.51	70	DMBW	2.14	40
BSBN	0.44	85	DLTN	1.26	70
BSBW	0.44	60	DLTW	1.26	45
BMTN	0.32	90	DLBN	1.06	60
BMTW	0.32	65	DLBW	1.06	35
BMBN	0.27	80			
BMBW	0.27	55	dSTN	7.02	75
BLTN	0.15	85	dSTW	7.02	50
BLTW	0.15	60	dSBN	5.98	65
BLBN	0.13	75	dSBW	5.98	40
BLBW	0.13	50	dMTN	4.32	70
			dMTW	4.32	45
CSTN	2.14	85	dMBN	3.68	60
CSTW	2.14	60	dMBW	3.68	35
SCBN	1.82	75	dLTN	2.14	65
CSBW	1.82	50	dLTW	2.14	40
CMTN	1.32	80	dLBN	1.84	55
CMTW	1.32	55	dLBW	1.84	30

Table VI-2 shows what the combination and the percent of operations associated with each possible score are.

APPENDIX VI TABLE 2 SCORE AND PROBABILITY OF ACHIEVING IT

SCORE	COMBINATIONS	% OF OPERATION
100	ASTN	0.31
95	AMTN, BSTN	0.71
90	ASBN, ALTN, BMTN	0.68
85	AMBN, BSBN, BLTN, CSTN	2.89
80	ALBN, BMBN, CMTN, DSTN	5.75
75	ASTW, BLBN, CSBN, CLTN, DMTN, dSTN	12.44
70	AMTW, BSTW, CMBN, DSBN, DLTN, dMTN	10.87
65	ASBW, ALTW, BMTW, CLBN, DMBN, dSBN, dLTN	11.50
60	AMBW, BSBW, BLTW, CSTW, DLBN, dMBN	7.63
55	ALBW, BMBW, CMTW, DSTW, dLBN	7.59
50	BLBW, CSBW, CLTW, DMTW, dSTW,	12.13
45	CMBW, DSBW, DLTW, dMTW,	10.16
40	CLBW, DMBW, dSBW, dLTW	10.82
35	DLBW, dMBW	4.74
30	dLBW	1.84
TOTAL	60	100.06

If we look at the Table VI-2 we can see that all the possibilities achieving a score higher or equal to 80 points are in narrow valley with the most stringent effluent standard (100 mg/l, no effluent).

At 75 points then appears for the first time a possibility with a d classified stream (1,000 mg/l). So in order to assess the percentage of operators who will face a very high risk of not being able to undertake placer mining under the proposed guidelines, we should place the separation line at 75 and eliminate the dSTN possibility.

Using this assumption it would appear that 16 percent of operators will be facing a very high level of risk, and may have little choice but quit placer mining or relocate.

(% of operations having a score higher than 75 minus dSTN possibility 22.78% - 7.02% = 15.75%.)

(d) <u>Sensitivity analysis</u>

Some concerns have been expressed about the relevance of the size of operation factor for the following reasons:

- Experience shows that many smaller operations are more viable than large.
- Smaller operations have greater flexibility in methods of water use.
- Small operations in a narrow valley may have as much ability to operate as a large operation in a wide valley.

There is also the fact that the model is sensitive to the choice of the percentage of operators mining narrow valleys since it has been considered a major factor and weighted accordingly.

So, in order to meet all of those concerns we have developed a sensitivity analysis around those two factors. The risk model was

done four times using the same methodology as explained previously. The three other risk models are the following:

- using again the four factors but this time assuming 75% of operations being in narrow valley;
- using three factors (stream classification, time in business, valley width), assuming 75% of operations being in narrow valley;
- using three factors, with 50% of operations being in narrow valleys.

The respective results were as follows: 23, 28 and 19 percent of operators will be facing a very high level of risk, and may be forced to quit placer mining or relocated, mainly because they are mining narrow valleys and have to meet a 100 mg/l standard for their effluent.

Appendix VII

PRESENT VALUE

APPENDIX VII

PRESENT VALUE

The purpose of this appendix is to explain the concept of the present value.

Let us start with the following example: suppose that you are owed $100. Would you prefer to be paid today, or in one year? Usually people will prefer to be paid today because they feel that $100 today will be worth more than $100 in one year. This is for two main reasons:

1) If the $100 is received today, it can be invested in some way (bank, bonds, shares, etc.) so it will yield a return on the investment. Therefore the value of $100 in one year will be the face value plus the return (interest, dividends, profits, etc.).

2) There is always a risk that the $100 will not be paid back next year, for some reason (death, default, bankruptcy, etc.). Therefore the longer the delay in pay back, the higher the risk is that it will not occur.

The present value of an amount that one expects to receive at a specific time in the future is the amount which if invested today at a designated rate of return, would accumulate to the future amount. Thus to make suitable comparisons between cash flows in different years in the future, it is necessary to express those cash flows in their present value form.

To calculate the present value, a discount rate is applied against the face value. This discount rate is exactly the opposite of the expected rate of return (or compound interest). The choice is therefore a function of the yield of expected investment opportunities and one's personal perception of risk.

Under the SEIA's guidelines stated by the Treasury Board, the discount rate to be used is 10 percent. A sensitivity analysis is also done using a 5 percent and 15 percent discount rate.

Table VII-1 shows the present value of $1 using these three discount rates. Inspection of Table VII-1 will reveal two fundamental points about present values:

1) Present value decreases as the number of years of future payment are increased.

2) Present value decreases as the percentage discount rate increases.

APPENDIX VII TABLE 1 PRESENT VALUE OF $1

NUMBER OF YEARS	DISCOUNT RATE 5%	10%	15%
1	0.952	0.909	0.870
2	0.907	0.826	0.756
3	0.864	0.751	0.658
4	0.823	0.683	0.572
5	0.784	0.621	0.497
6	0.746	0.564	0.432
7	0.711	0.513	0.376
8	0.677	0.467	0.327
9	0.645	0.424	0.284
10	0.614	0.386	0.247
11	0.585	0.350	0.215
12	0.557	0.319	0.187
13	0.530	0.290	0.163
14	0.505	0.263	0.141
15	0.481	0.239	0.123
20	0.377	0.149	0.061
25	0.295	0.092	0.030
30	0.231	0.057	0.015
35	0.181	0.036	0.008
40	0.142	0.022	0.004
45	0.111	0.014	0.002
50	0.087	0.009	0.001
60	0.054	0.003	-----
70	0.033	0.001	-----
80	0.020	-----	-----
90	0.012	-----	-----
100	0.008	-----	-----

Note: The present value of $1 is only $0.50 in 14 years, 7 years and 5 years using, respectively, 5, 10 and 15 percent as discount rate.

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